Redis as a Reliable Work Queue

Percona University 2015-02-12

Introduction

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Bronto Software

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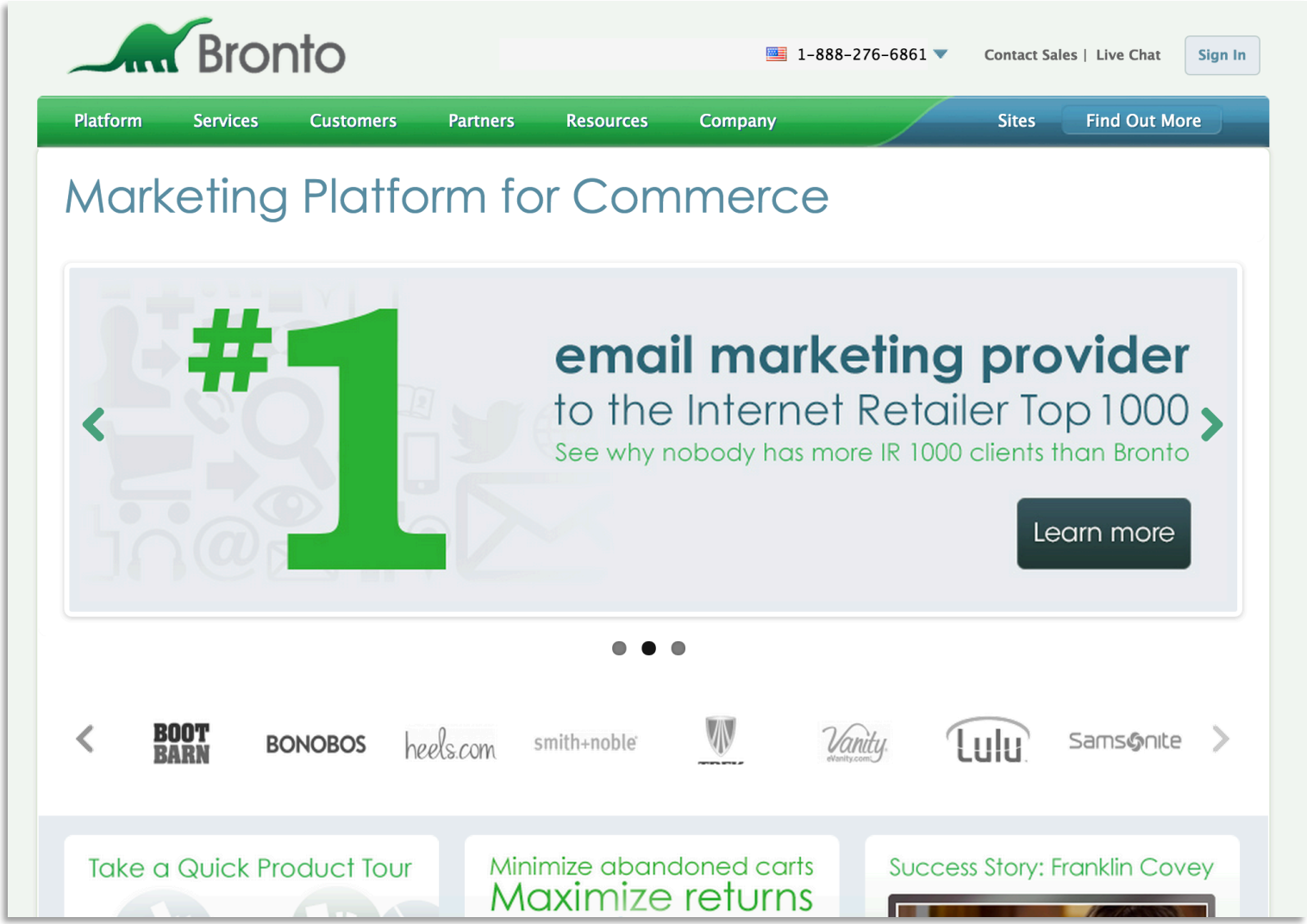
Introduction



Introduction

Bronto

Introduction

Bronto Features

- Communication
  - Email
  - Social
  - SMS
- Contact Management
  - Manual
  - Segmentation
- Marketing Automation
  - Workflows
- Commerce Integration
  - Purchase History
  - Cart Recovery
- Integration
  - SOAP/REST API
  - Third Party Connectors

Introduction

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Cyber Monday 2014

Peak Daily Totals

Emails Sent	Events Processed
~170M per Day	~400M per Day
~2000 per Second	~4700 per Second

Peak Hourly Totals

Emails Sent	Events Processed
~14M per Hour	~32M per Hour
~3900 per Second	~8900 per Second

Distributed Work Queueing

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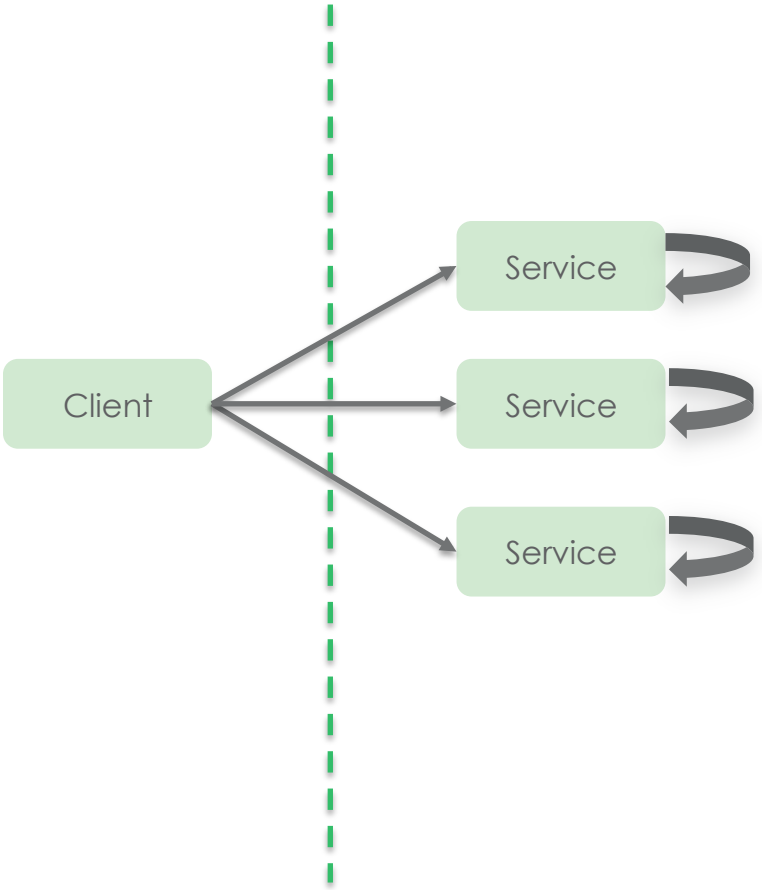
Local work queues…



Distributed Work Queueing

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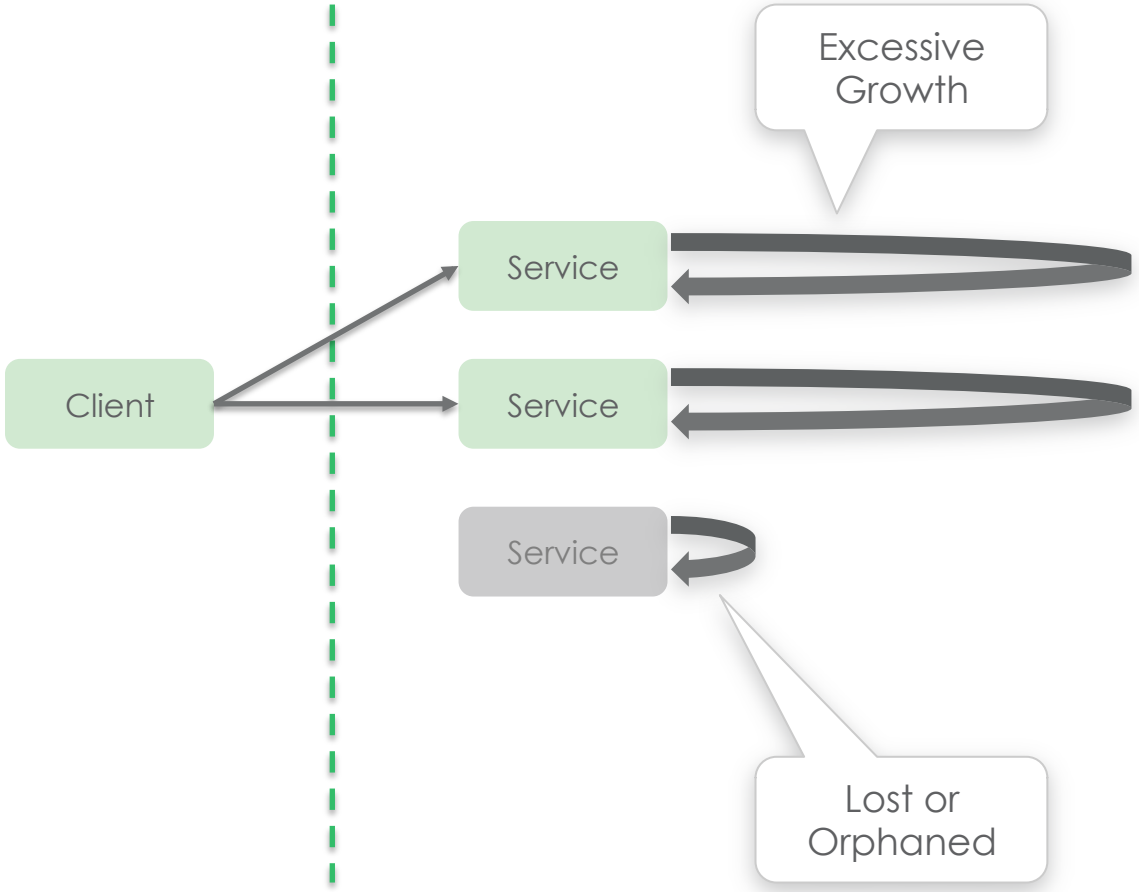
Local work queues…handle failure poorly



Distributed Work Queueing

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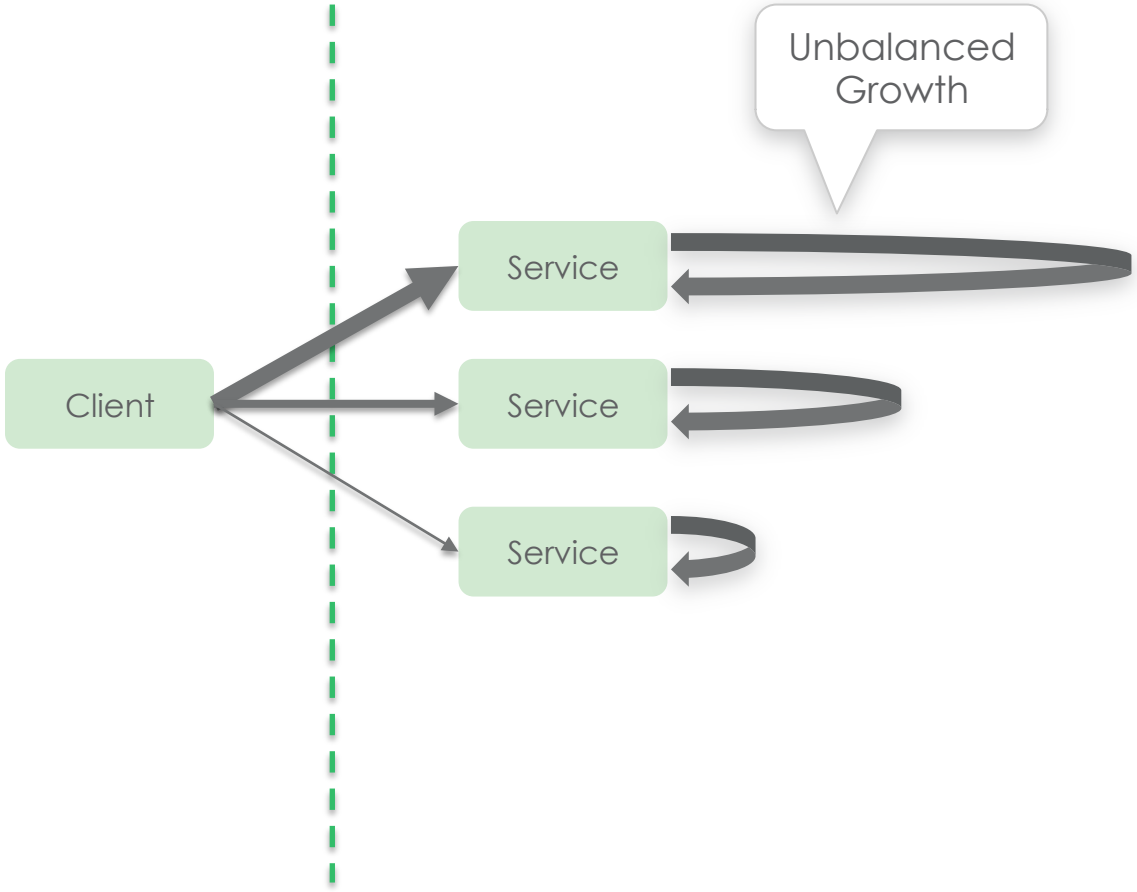
Local work queues…handle unbalanced loads poorly



Distributed Work Queueing

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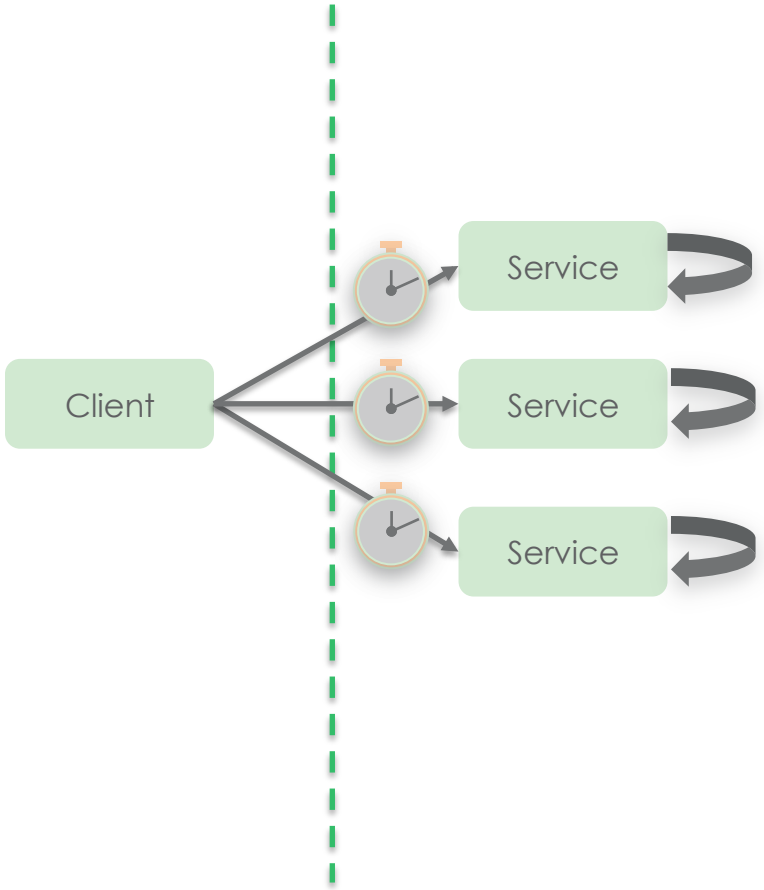
Local work queues… may be bad neighbors



Distributed Work Queueing

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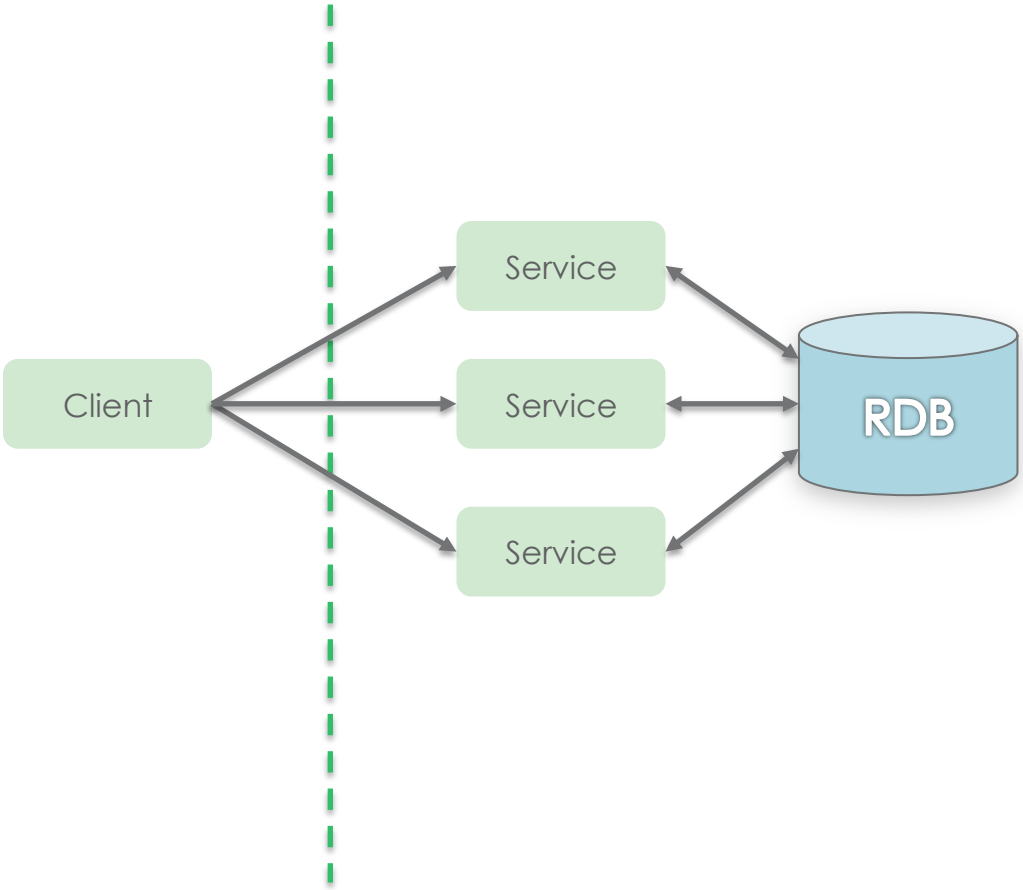
What about putting the work in a relational database?



Distributed Work Queueing

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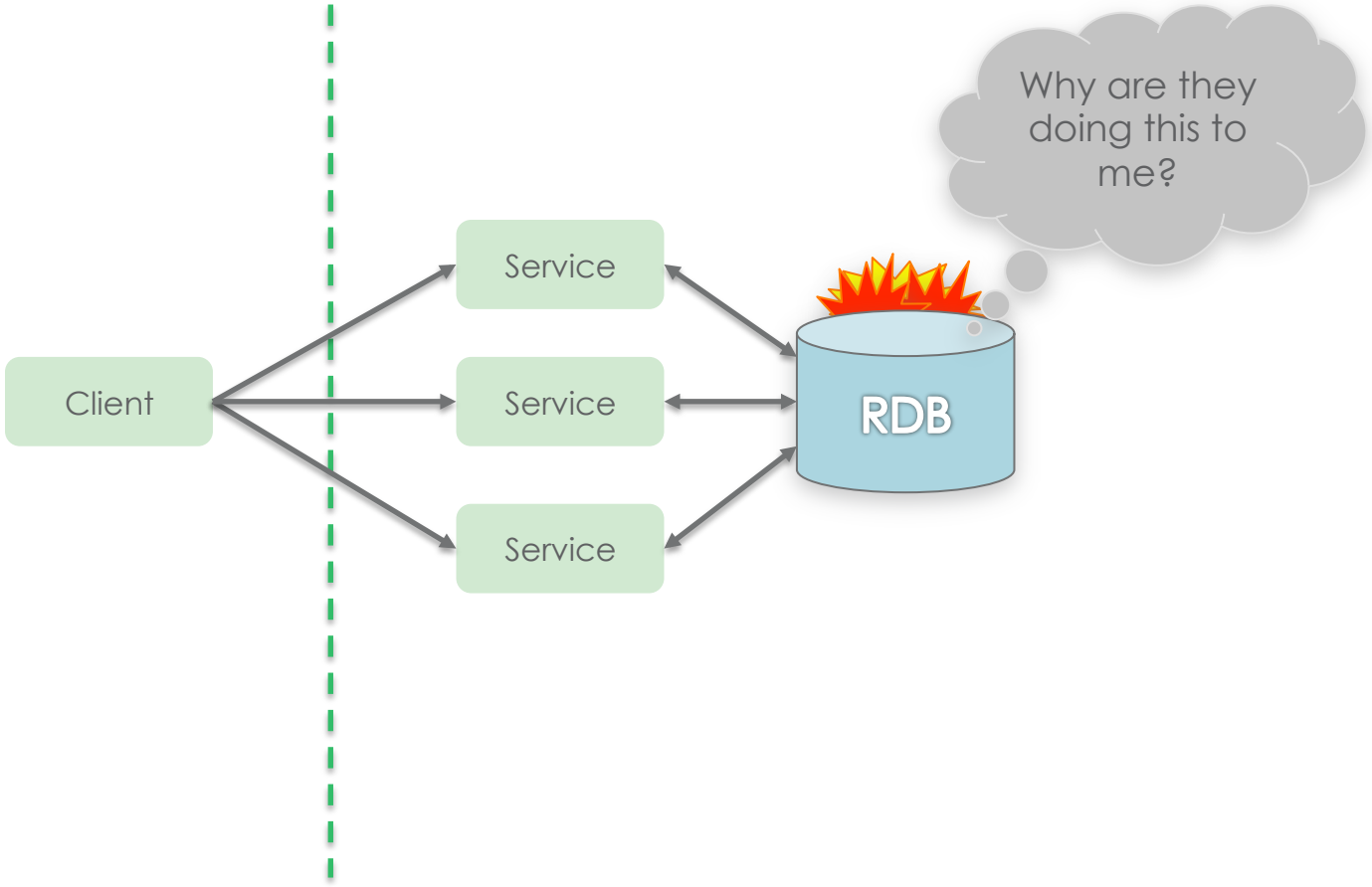
~~What about putting the work in a relational database?~~

Please don't do that…



Distributed Work Queueing

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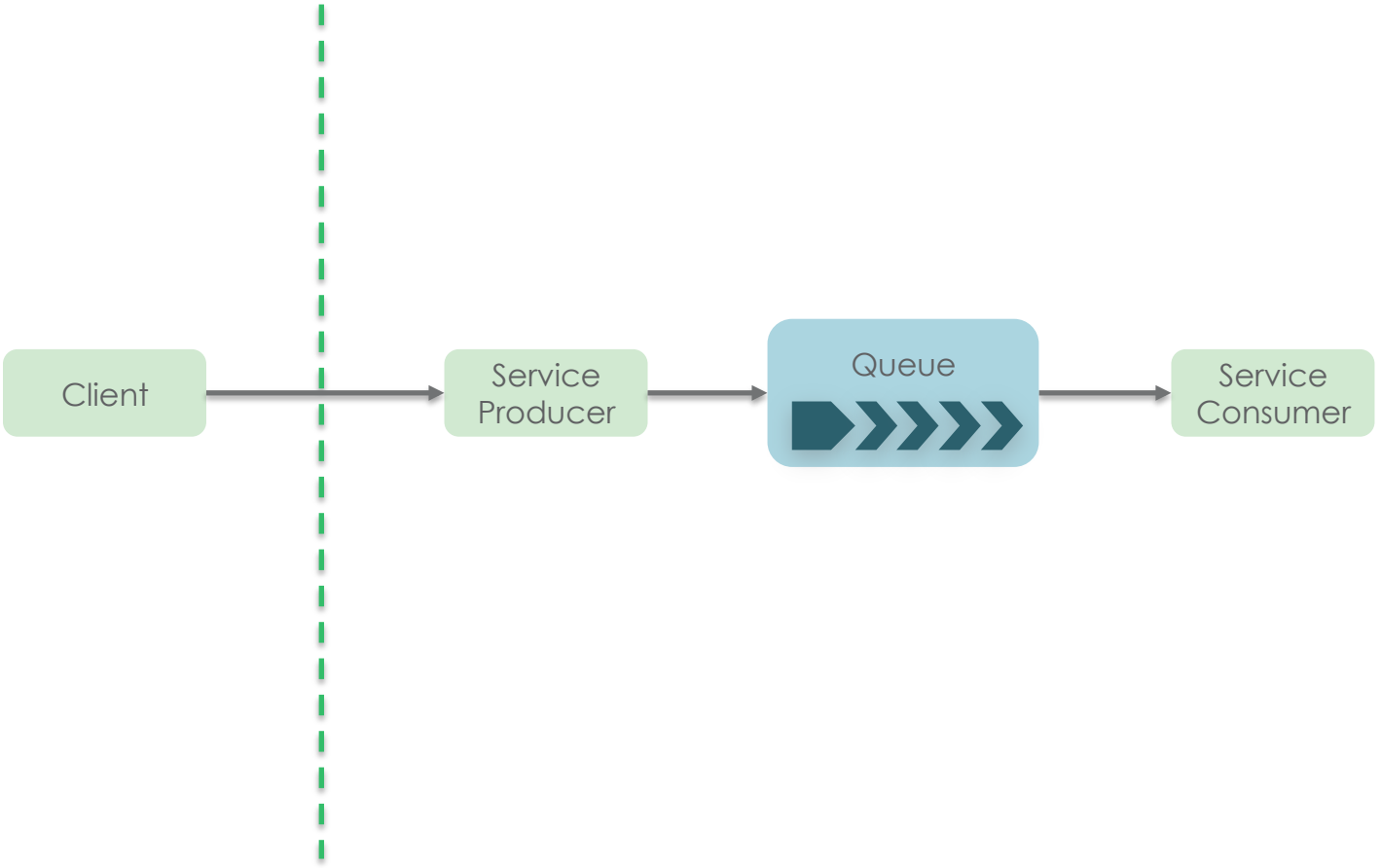
Distributed work queues…



Distributed Work Queueing

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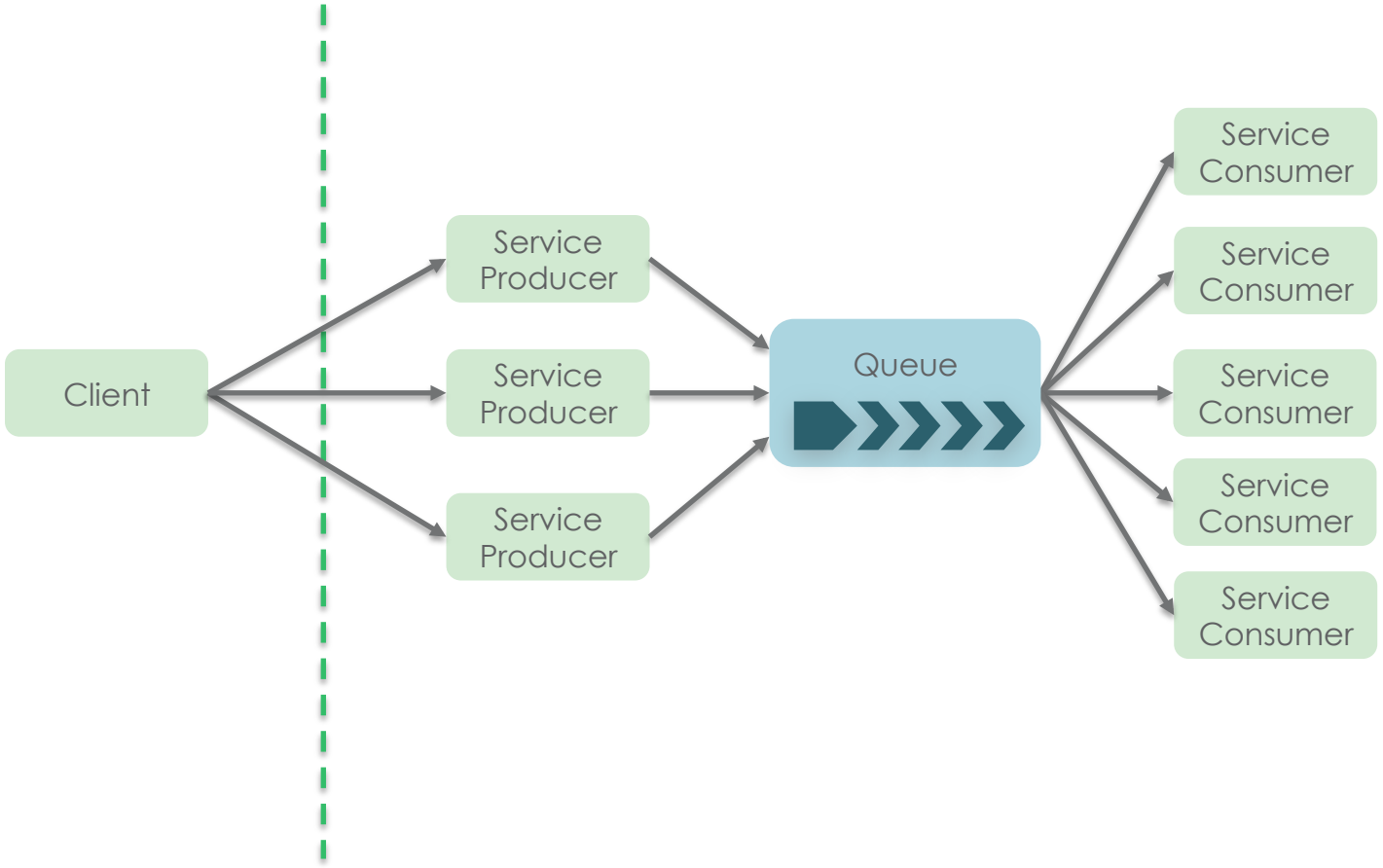
Distributed work queues…decouple producers and consumers



Distributed Work Queueing

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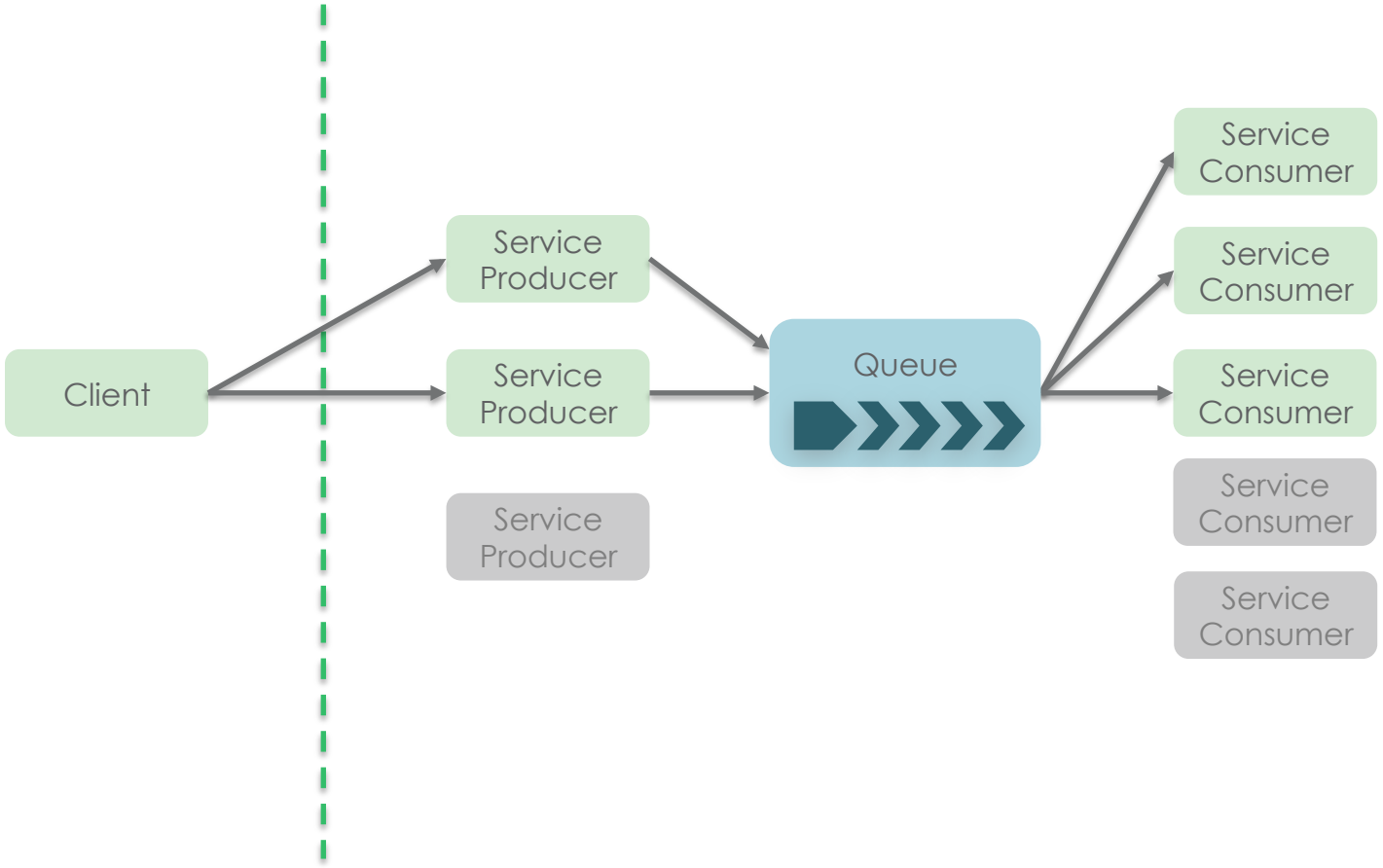
Distributed work queues…are more fault tolerant



Distributed Work Queueing

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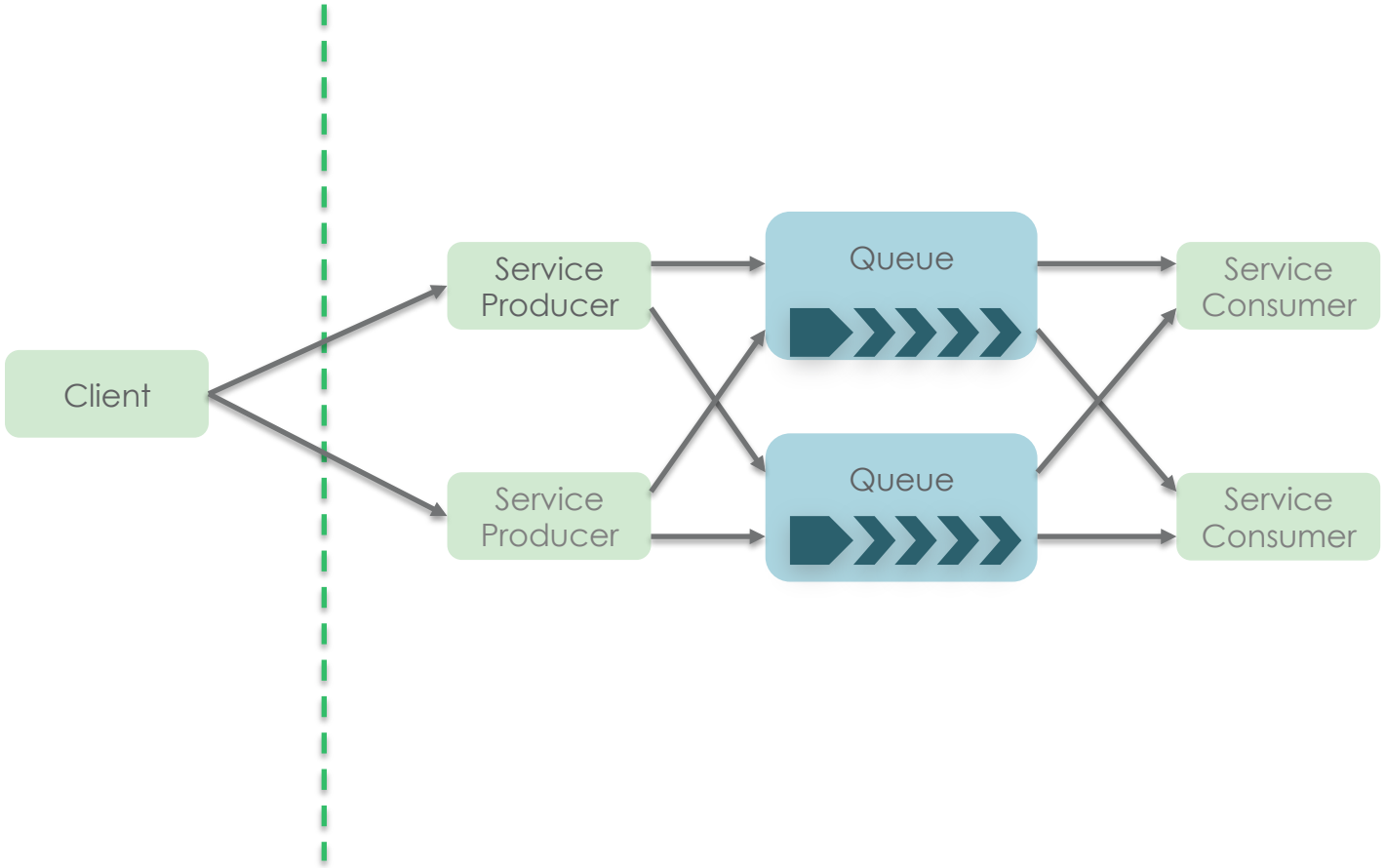
Distributed work queues… partition for availability and/or scale



Distributed Work Queueing

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Great… But where can I get one?

- Kafka
- Kestrel
- Starling
- BeanstalkD
- SwiftMQ
- RabbitMQ
- ActiveMQ
- Qpid
- Apollo
- SQS (Simple Queue Service)
- …and lots more I've simply forgotten or ignored

There are plenty of options in this space.

Distributed Work Queueing

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Why did we go with Redis?

- Existing deployment
- Existing operational experience
- Existing development experience
- Works well without specialized hardware
- Favorable balance of throughput vs. durability
- Flexibility to support alternate queue schemes (e.g. with key-based aggregation)

We don't regret building this on Redis, and we feel it will be a solid contribution to the open source ecosystem.

Redis

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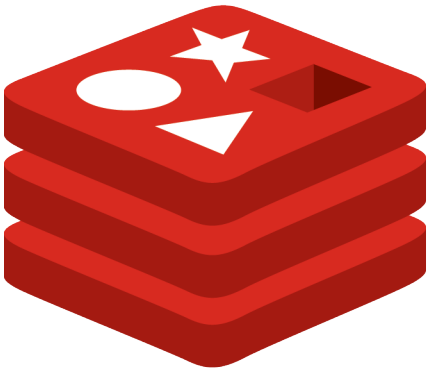
The fundamentals…

- NoSQL database
- Key/Value style
- Data structures
- Memory only
- Durable to disk
- Fast, fast, fast



redis

Redis

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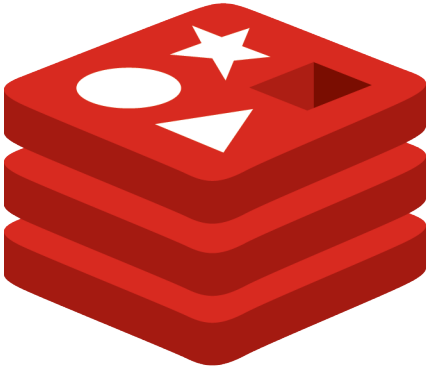
Under the covers…

- C application
- Single threaded
- Strongly consistent
- Durability via snapshots (RDB)
- Durability via redo logs (AOF)
- Scriptable on server-side (LUA)
- Simple protocol
- Replication



redis

Redis

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Is it ACID? No…

Single Operations

- Atomic
- Consistent
- Isolated

Multi Operation Transactions

- Atomic
- Isolated

Server Scripted Transactions

- Atomic
- Isolated

Redis is not consistent per ACID because it does not support rollbacks.
Redis is not durable per ACID because it does not require persistence to disk.

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Durability in Redis

RDB (Redis Database)

- Point in time snapshot
- Scheduled or on-demand
- Performed in a forked process
- Compact file format
- Fastest restore time
- Larger window for data loss

There are workloads that can make good use of the scheduled and/or explicit RDB snapshots, but the queue case is not one of them.

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Durability in Redis

AOF (Append Only File)

- Streaming log of operations
- Periodic log rewriting from live data via fork
- Reduced chance of corruption due to append only strategy
- Multiple fsync() policies
  - Never
  - Every second
  - Every operation
- Slightly reduced performance due to more frequent disk interaction

AOF with the 'every second' fsync policy is a good fit for us.

- No expected data loss due to process failure
- One second of potential data loss due to machine failure

Naïve Queueing

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Producer creates work payload

Naïve Queueing

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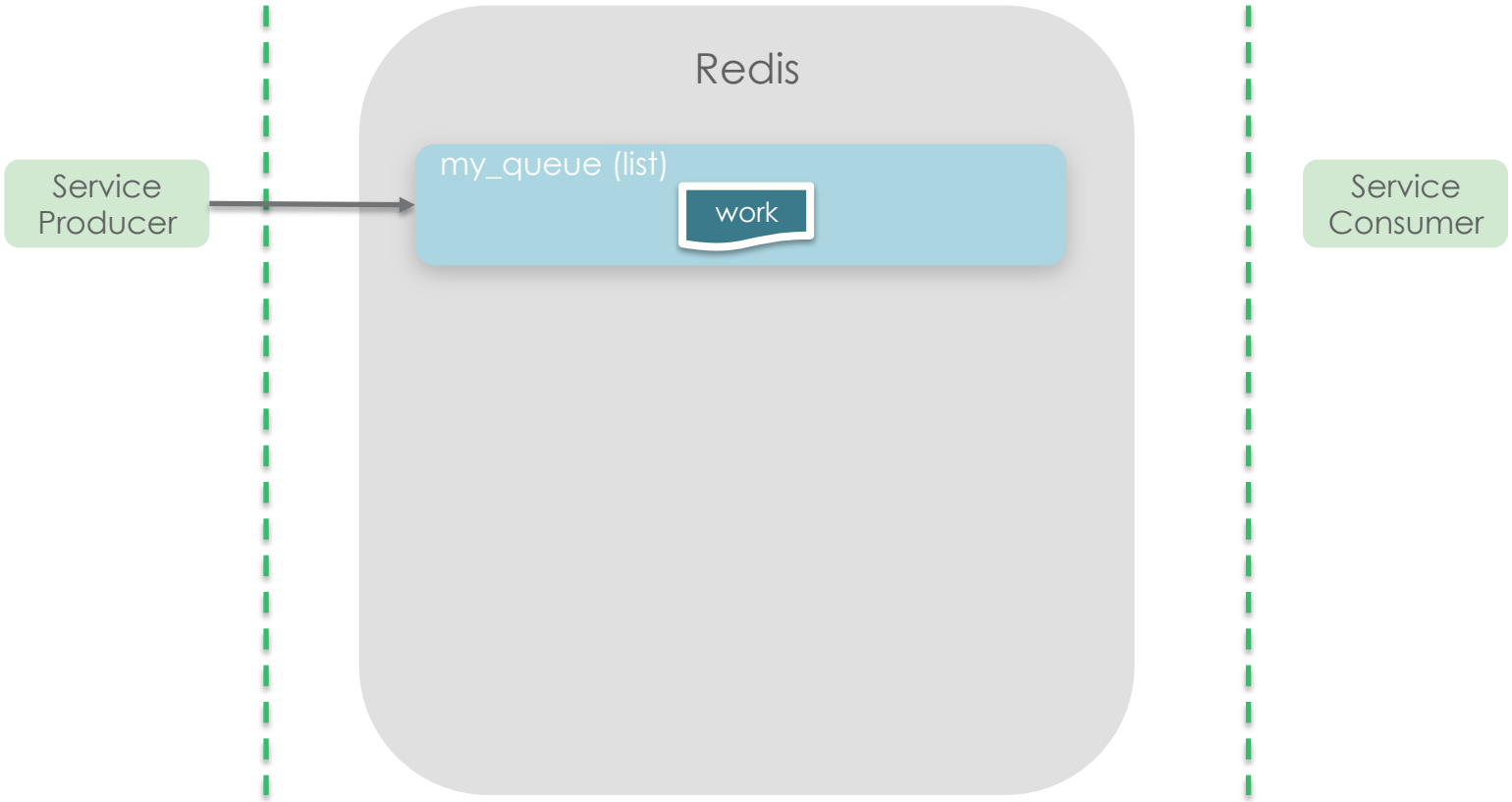
LPUSH my_queue work



Naïve Queueing

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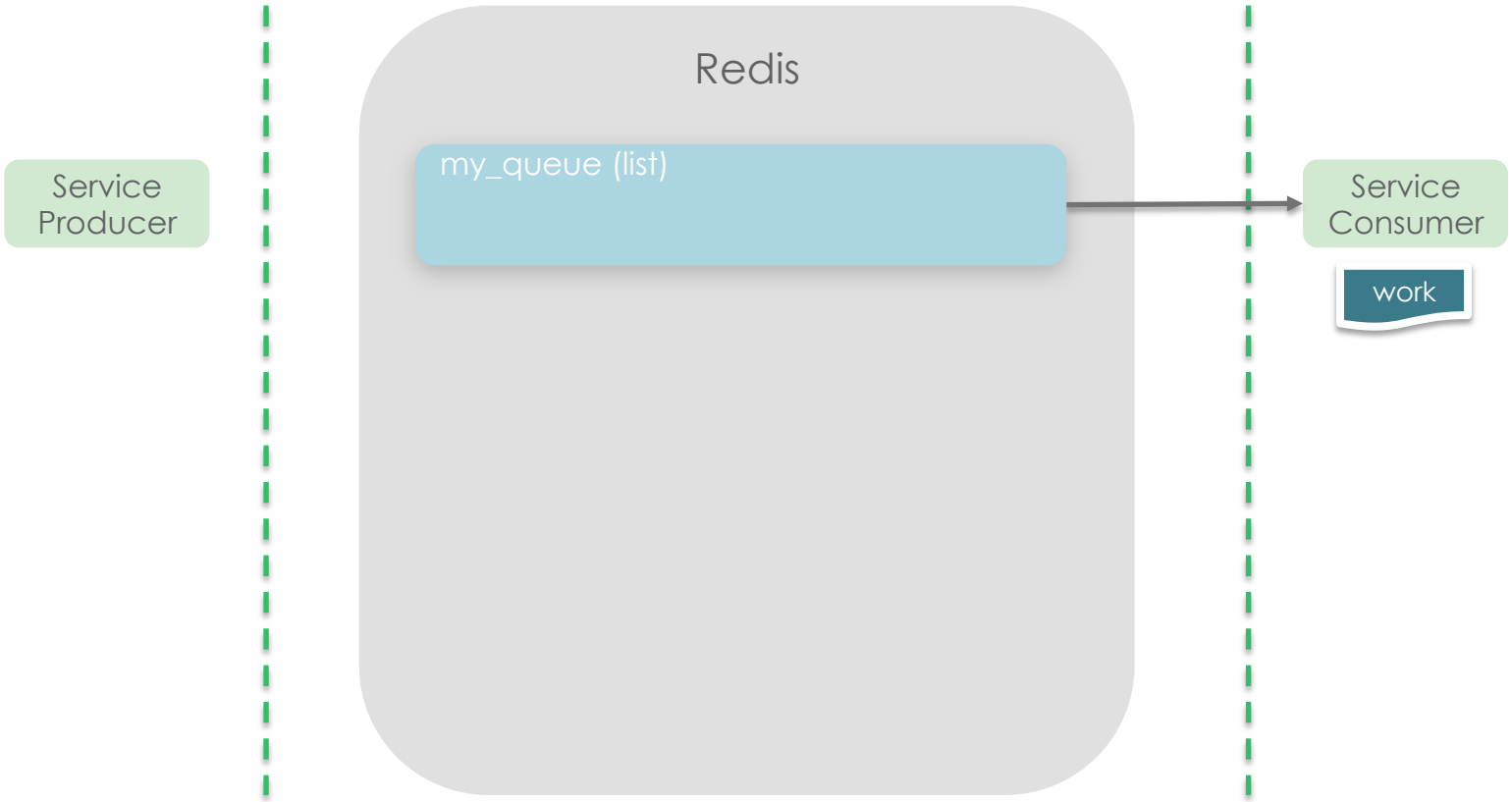
RPOP my_queue



Naïve Queueing

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Consumer processes work

Naïve Queueing

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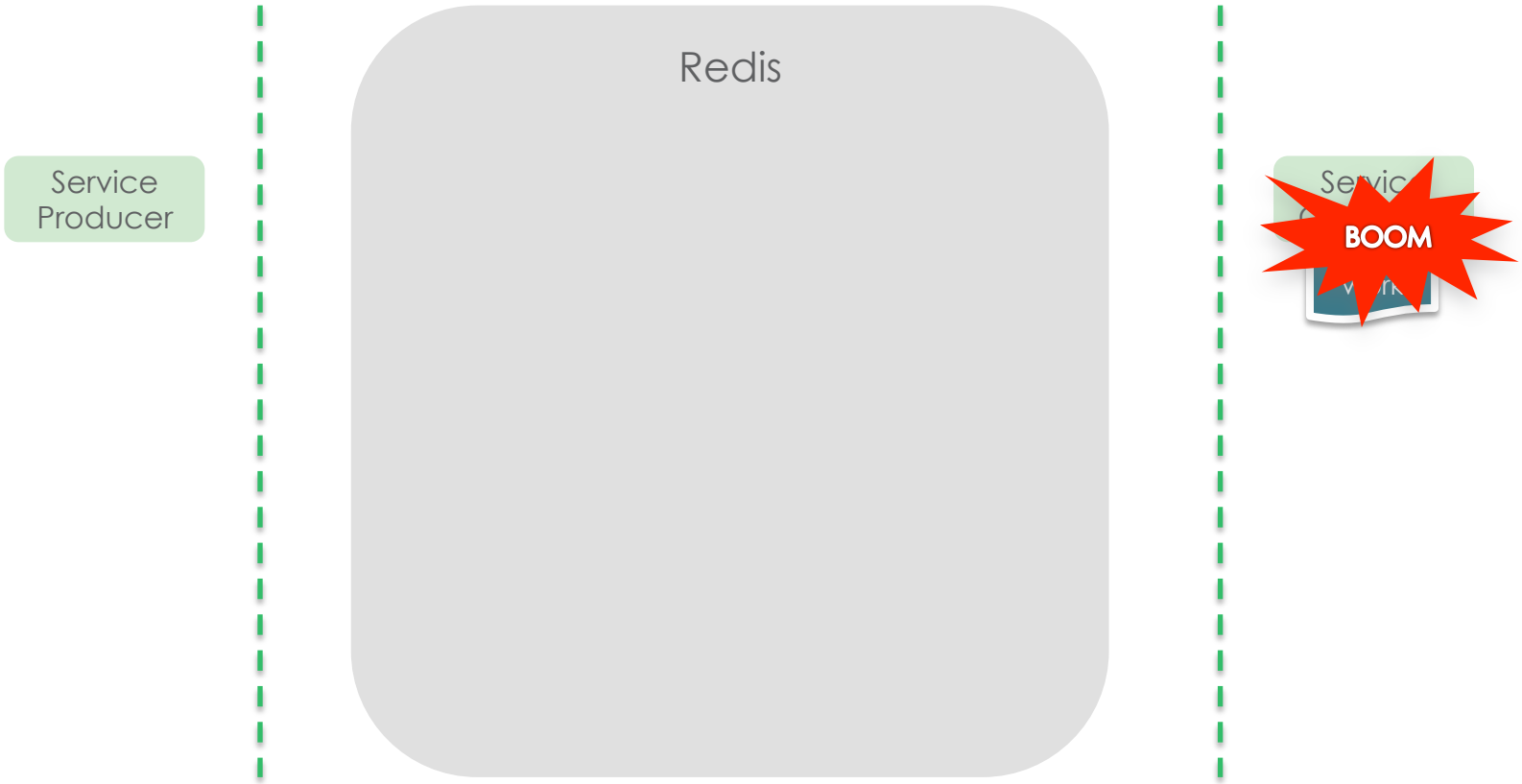
…but what if something goes wrong?



Reliable Queueing

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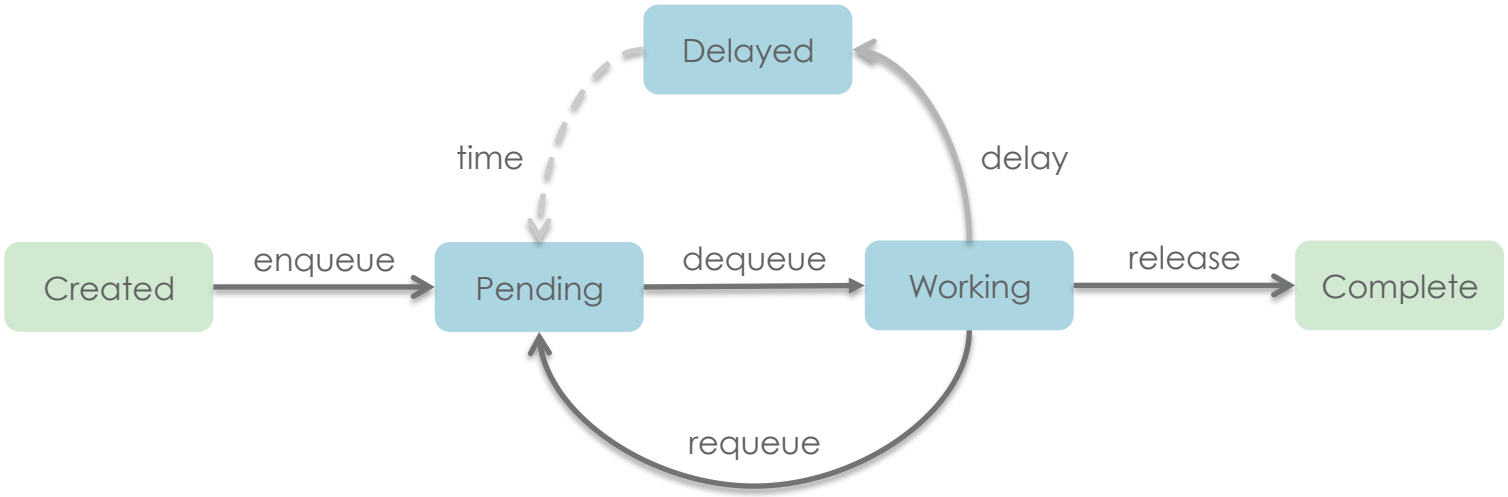
Naïve Queueing

Reliable Queueing



Reliable Queueing

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Redis and LUA Scripting

Think of it as a stored procedure.

- Loaded via EVAL
- Invoked via EVALSHA
- Atomic execution

```
-- Move the ready UUIDs from the delayed set back into the pending list.
-- These UUIDs are ready when their ZSCORE is less than that of the current time "now",
-- passed in as a parameter to this function.
-- They will be added back to the front of the pending list, rather than the end of it.
local function requeueDelayed(pendingList, delayedZSet, now)
    -- Get the UUIDs of the items ready to be requeued from the delayed set
    local ready_uuids = redis.call('ZRANGEBYSCORE', delayedZSet, 0, now)

    if #ready_uuids == 0 then
        return 0
    end

    -- Move the items from the delayed set to the front of the pending list
    zrem_safe(delayedZSet, ready_uuids)
    rpush_safe(pendingList, ready_uuids)

    return #ready_uuids
end
```

Reliable Queueing

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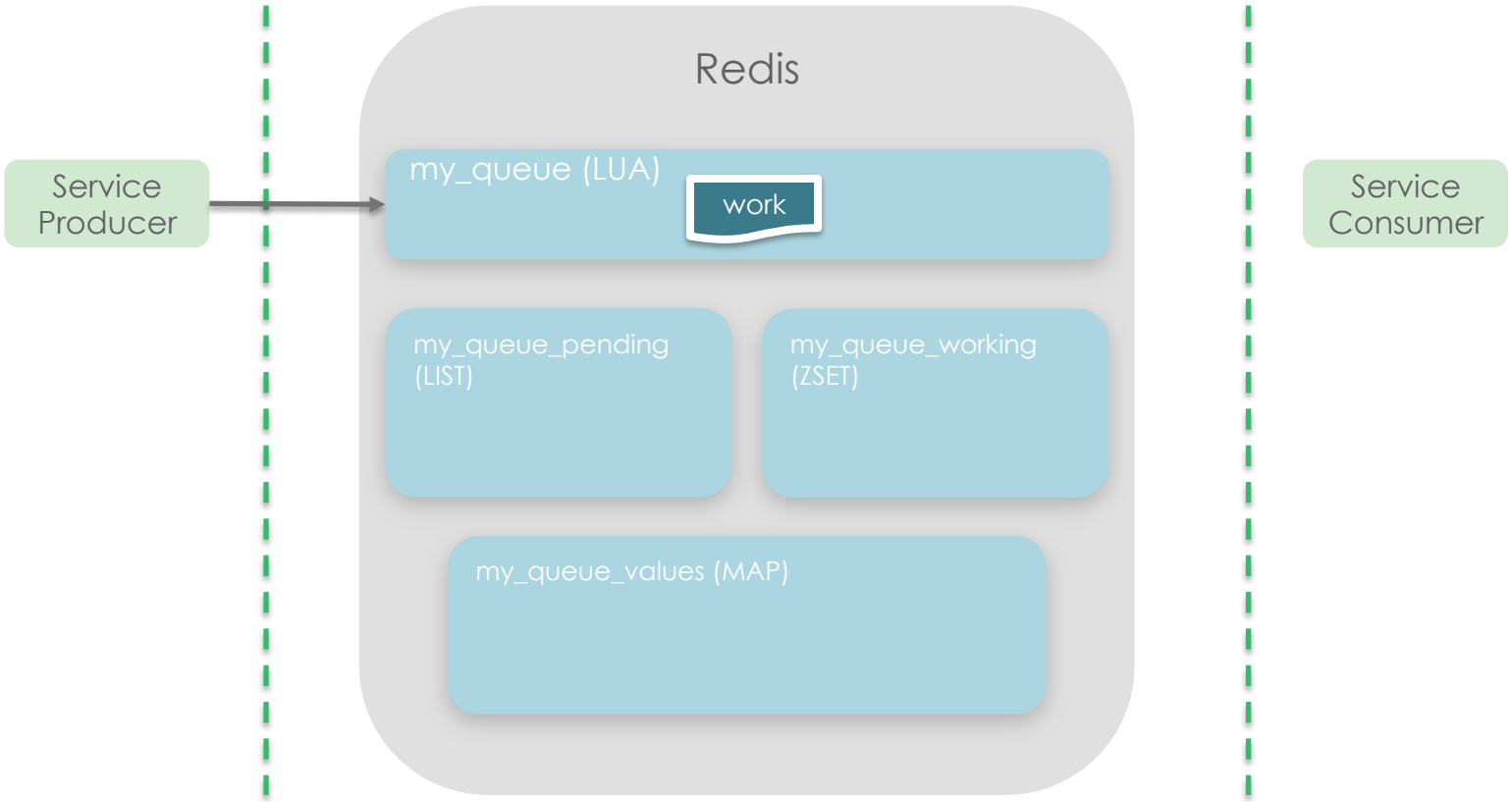
enqueue()



Reliable Queueing

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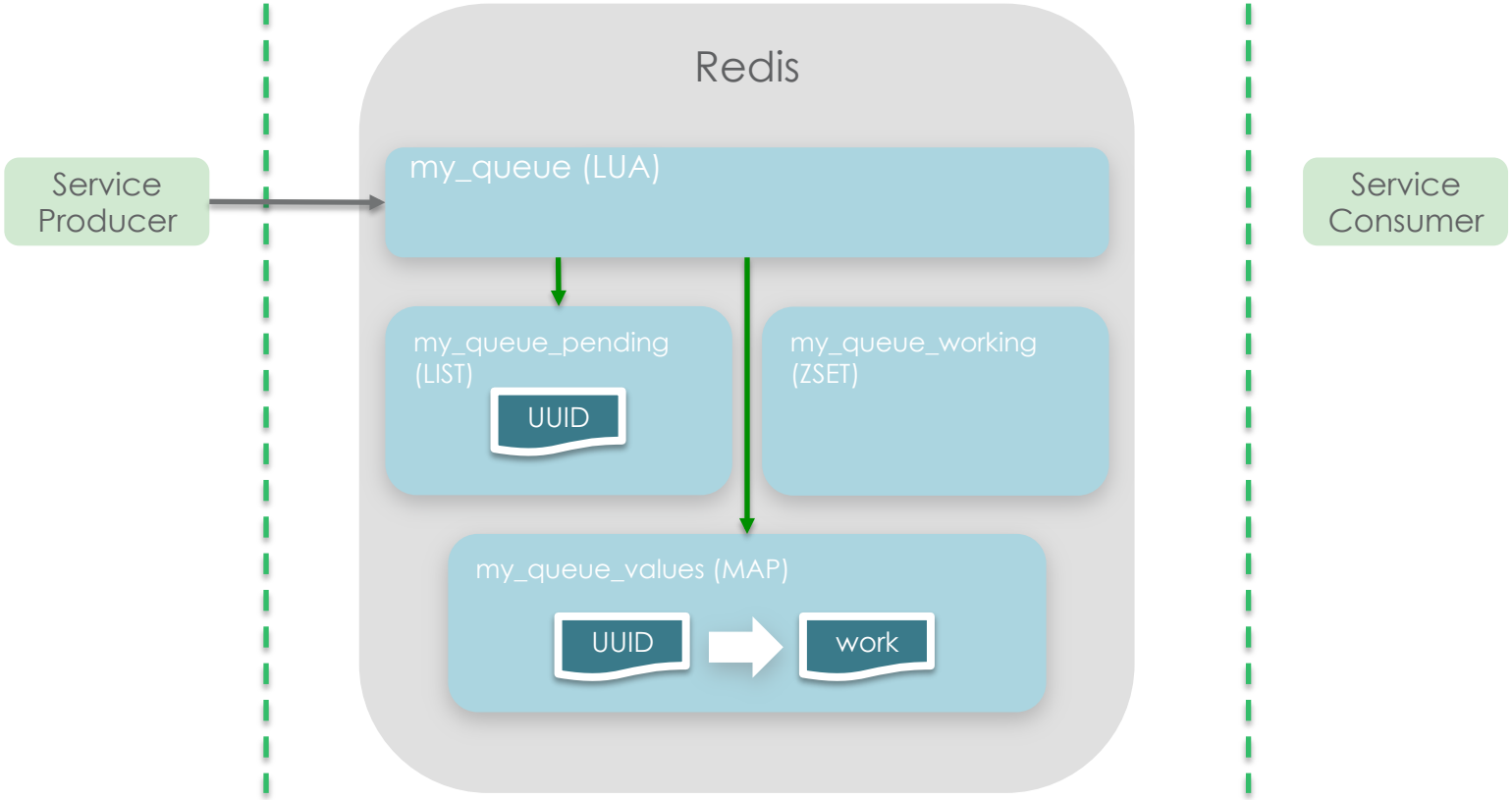
enqueue()

1. Generate {UUID}
2. LPUSH my_queue_pending {UUID}
3. HSET my_queue_values {UUID} {work}



Reliable Queueing

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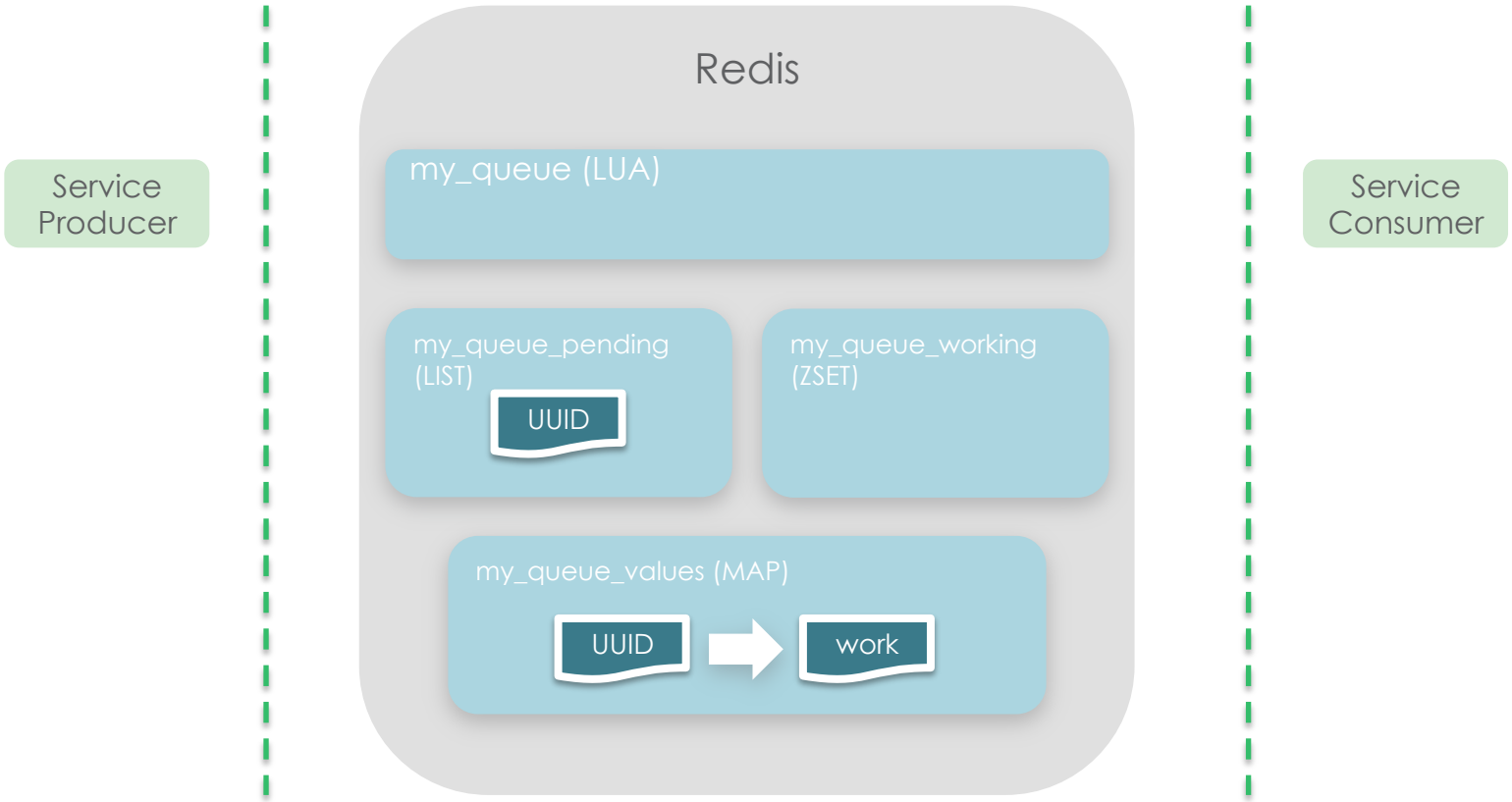
The work is now in the *pending* state.



Reliable Queueing

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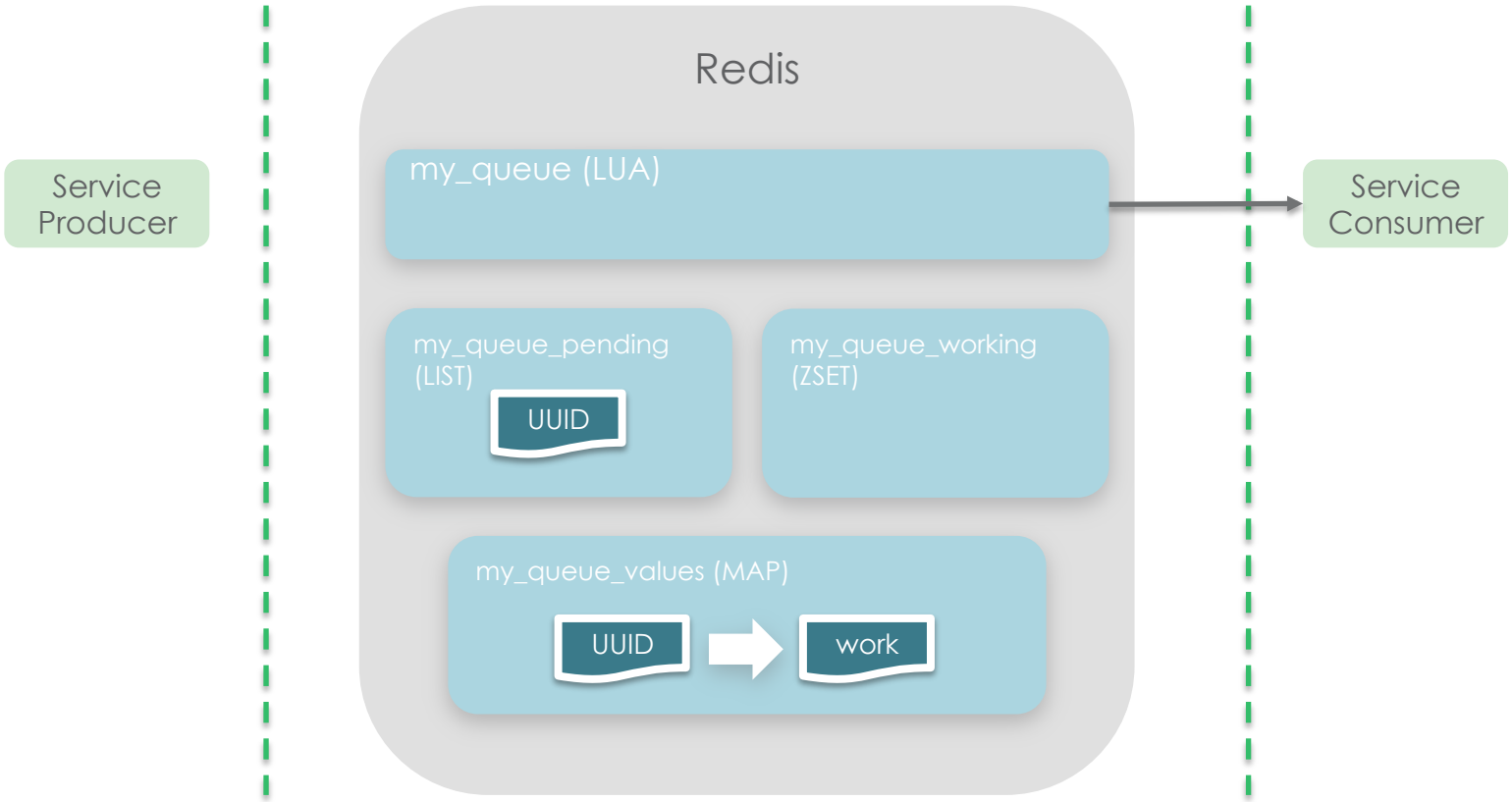
dequeue()



Reliable Queueing

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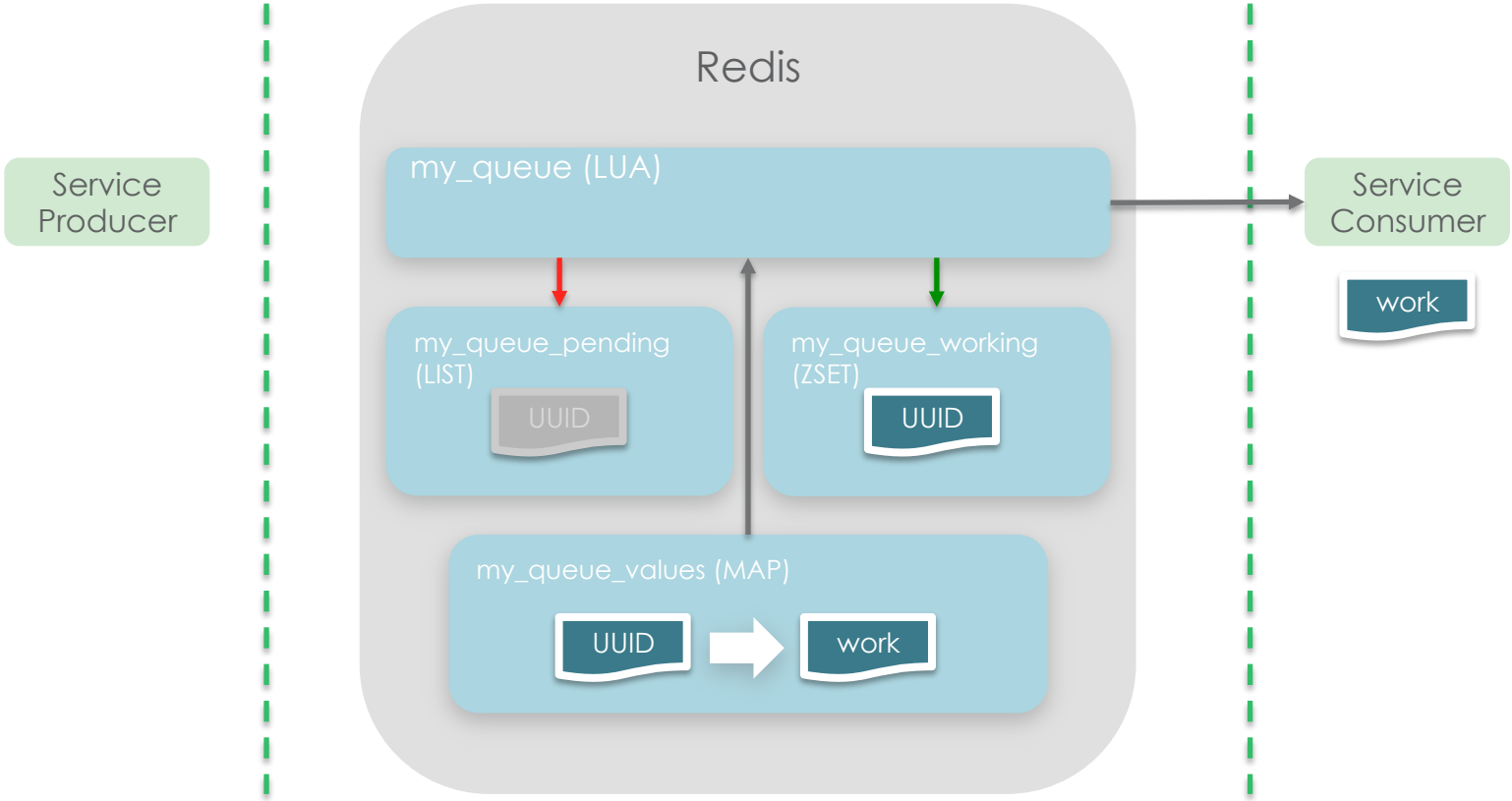
dequeue()

1. RPOP my_queue_pending
2. ZADD my_queue_working {timestamp} {UUID}
3. HGET my_queue_values {UUID}
4. Return {work} to consumer



Reliable Queueing

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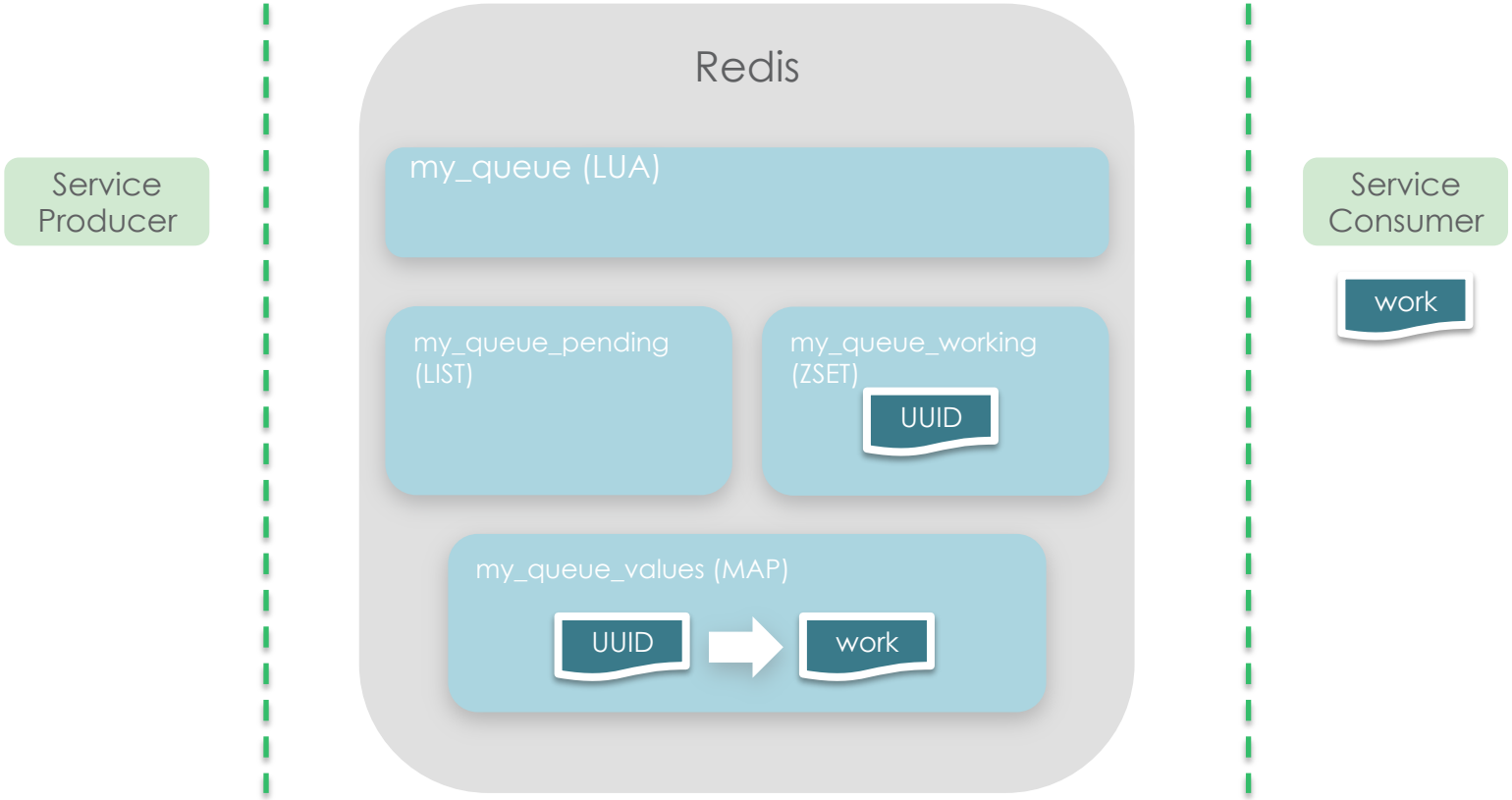
The work is now in the *working* state, safely dequeued, with an immutable copy still on the Redis server.



Reliable Queueing

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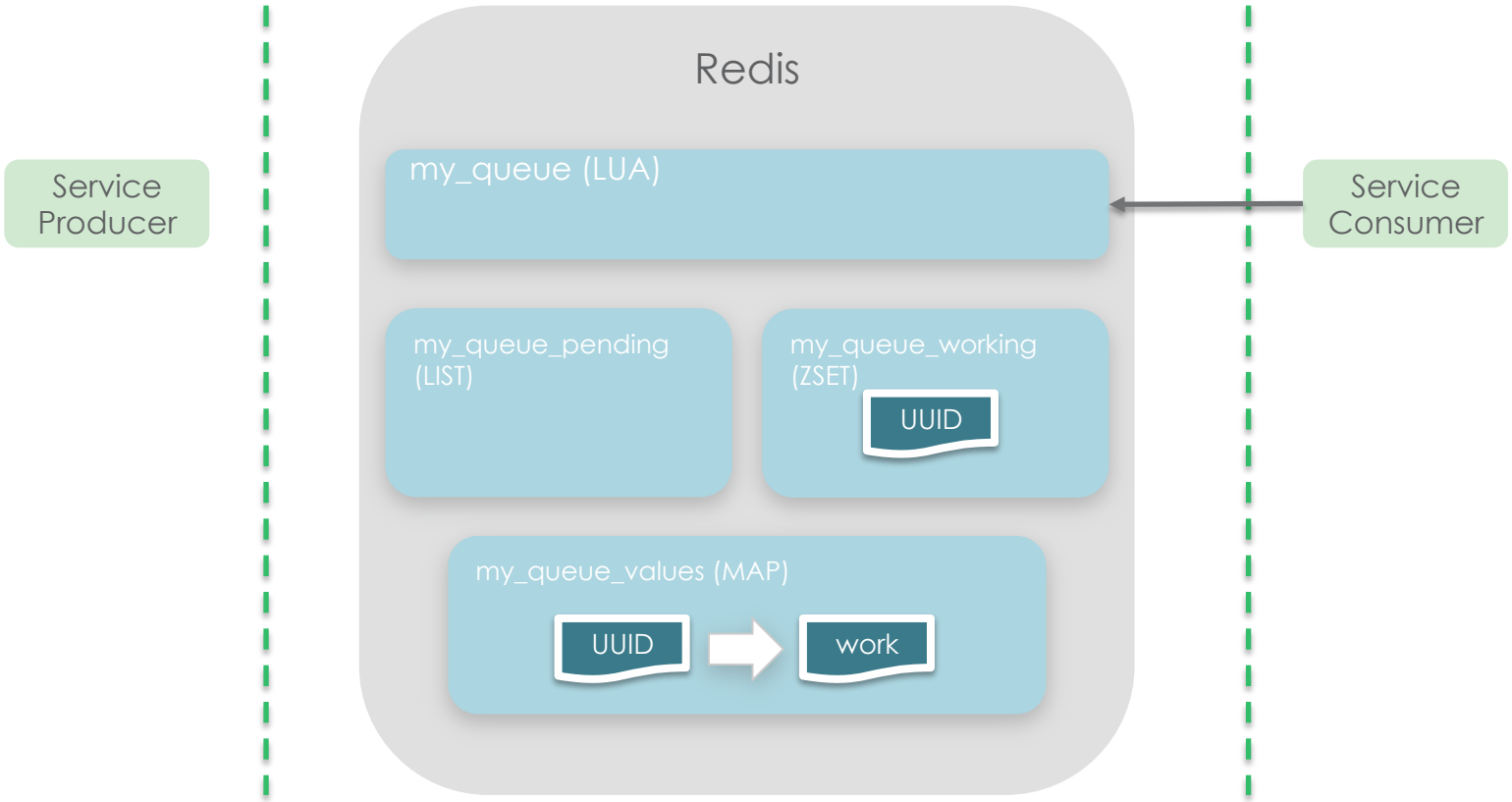
release()



Reliable Queueing

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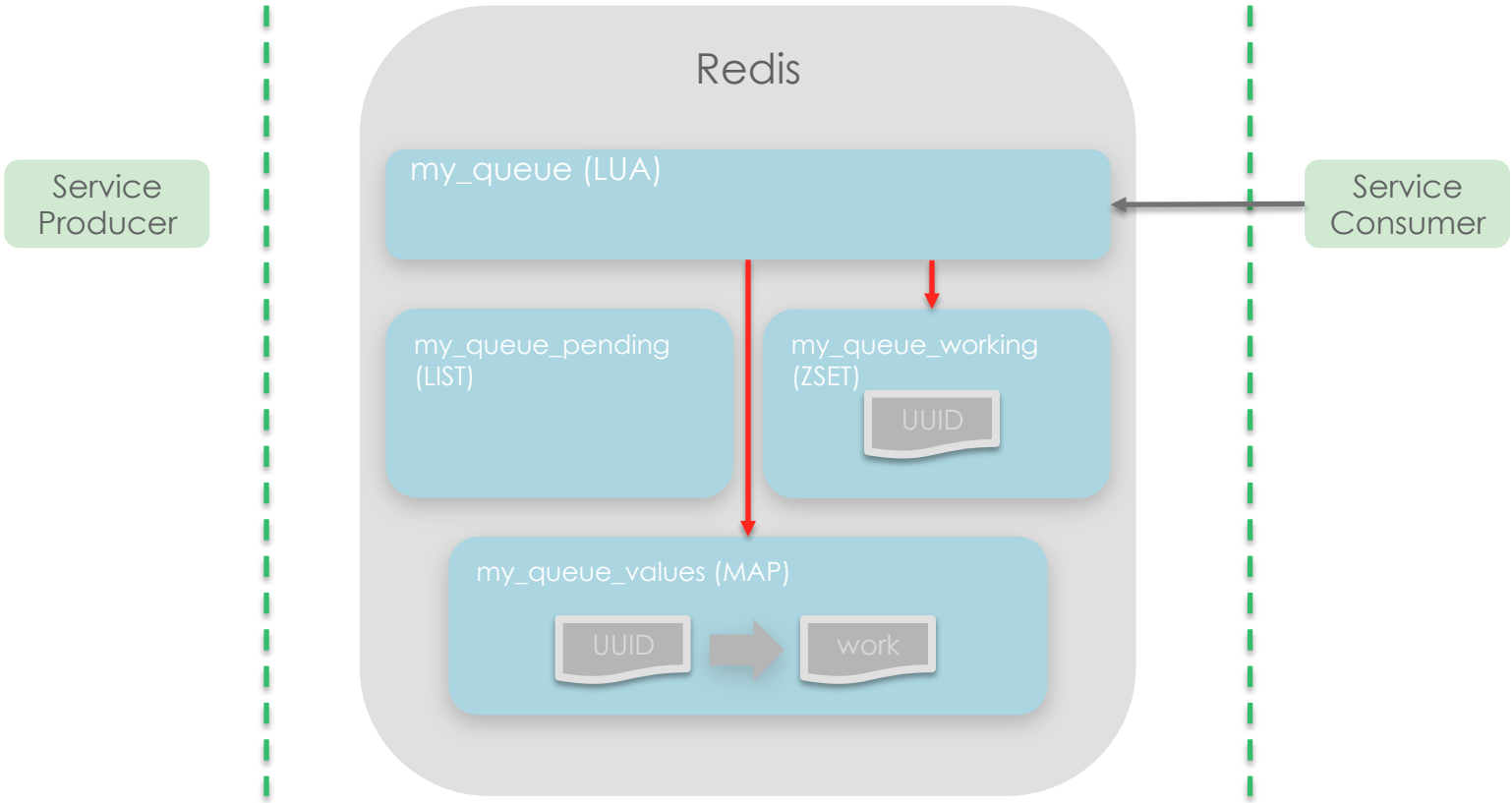
release()

1. ZREM my_queue_working {UUID}
2. HDEL my_queue_values {UUID}



Reliable Queueing

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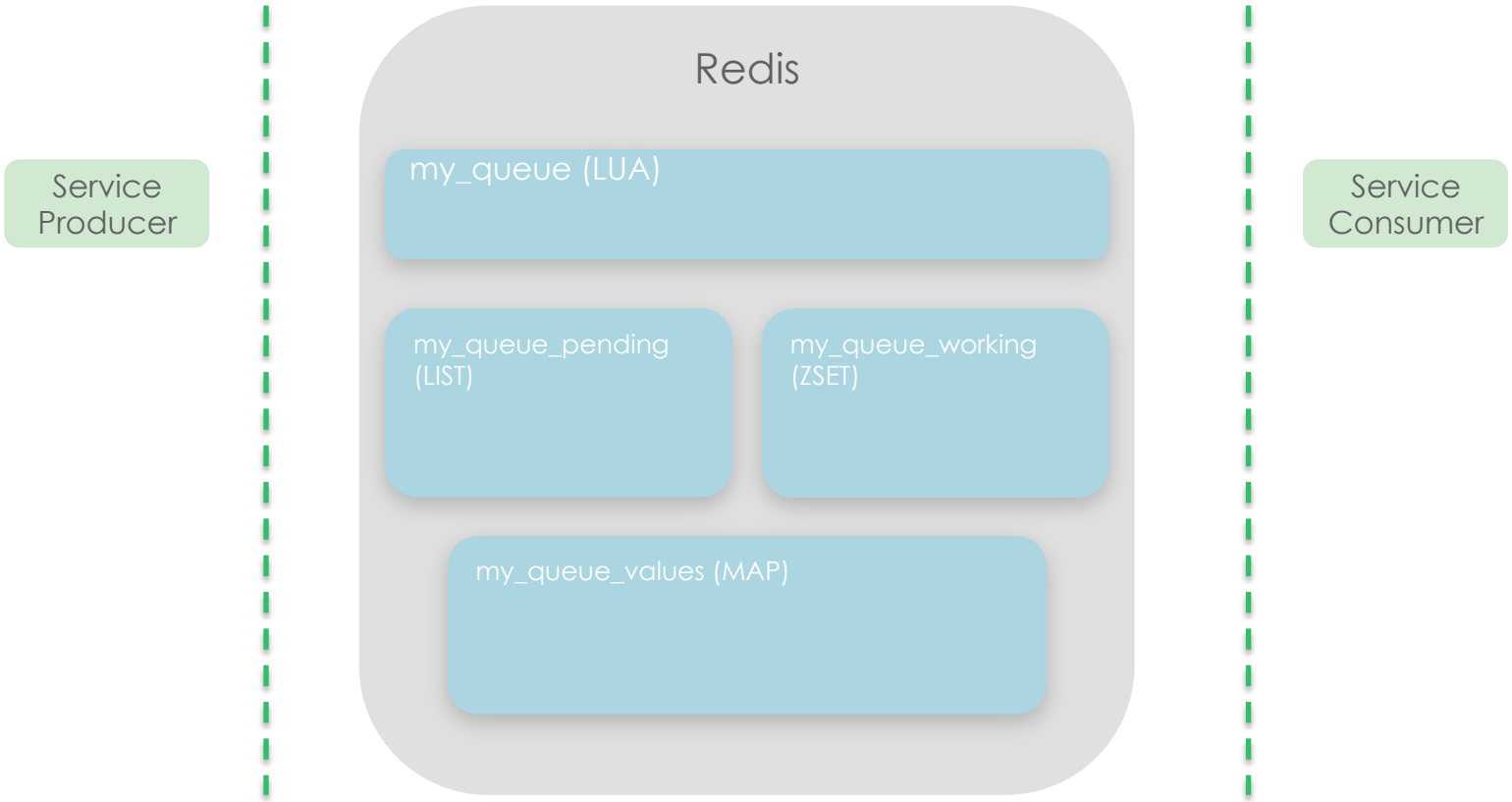
The work is now in the *completed* state, completely processed, with no copy remaining in Redis.



Reliable Queueing

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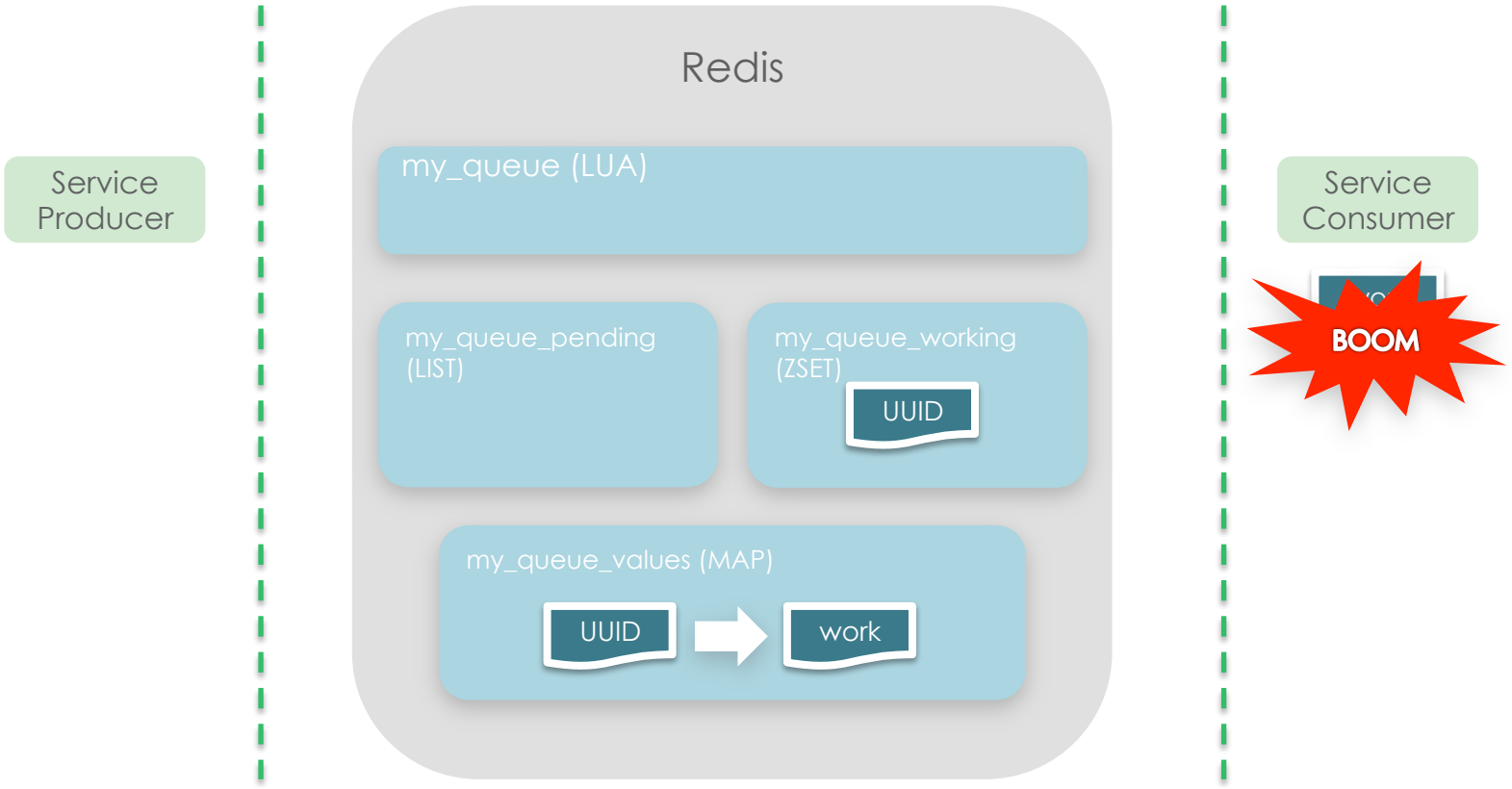
What if something goes wrong during processing?



Reliable Queueing

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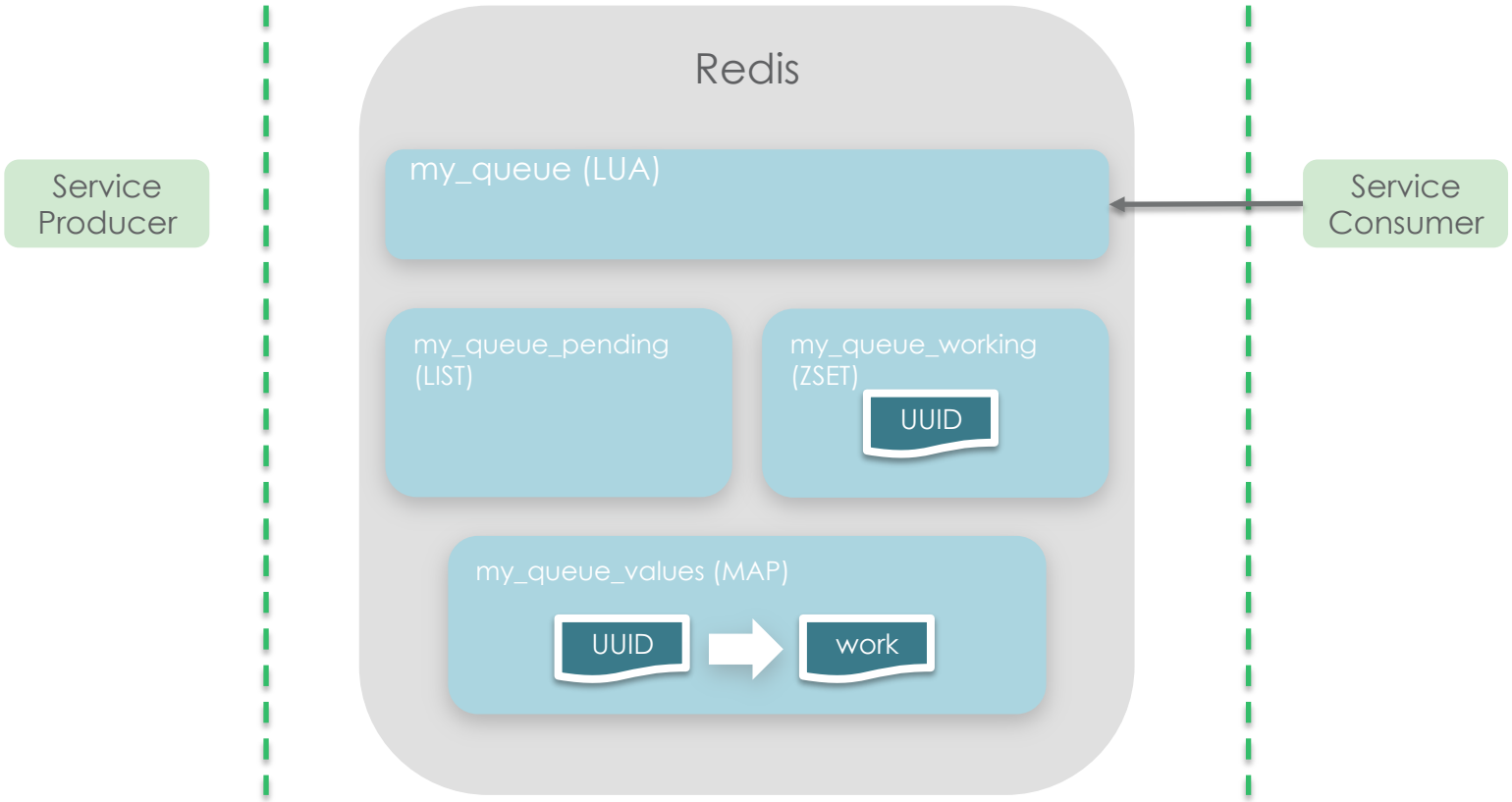
requeue()



Reliable Queueing

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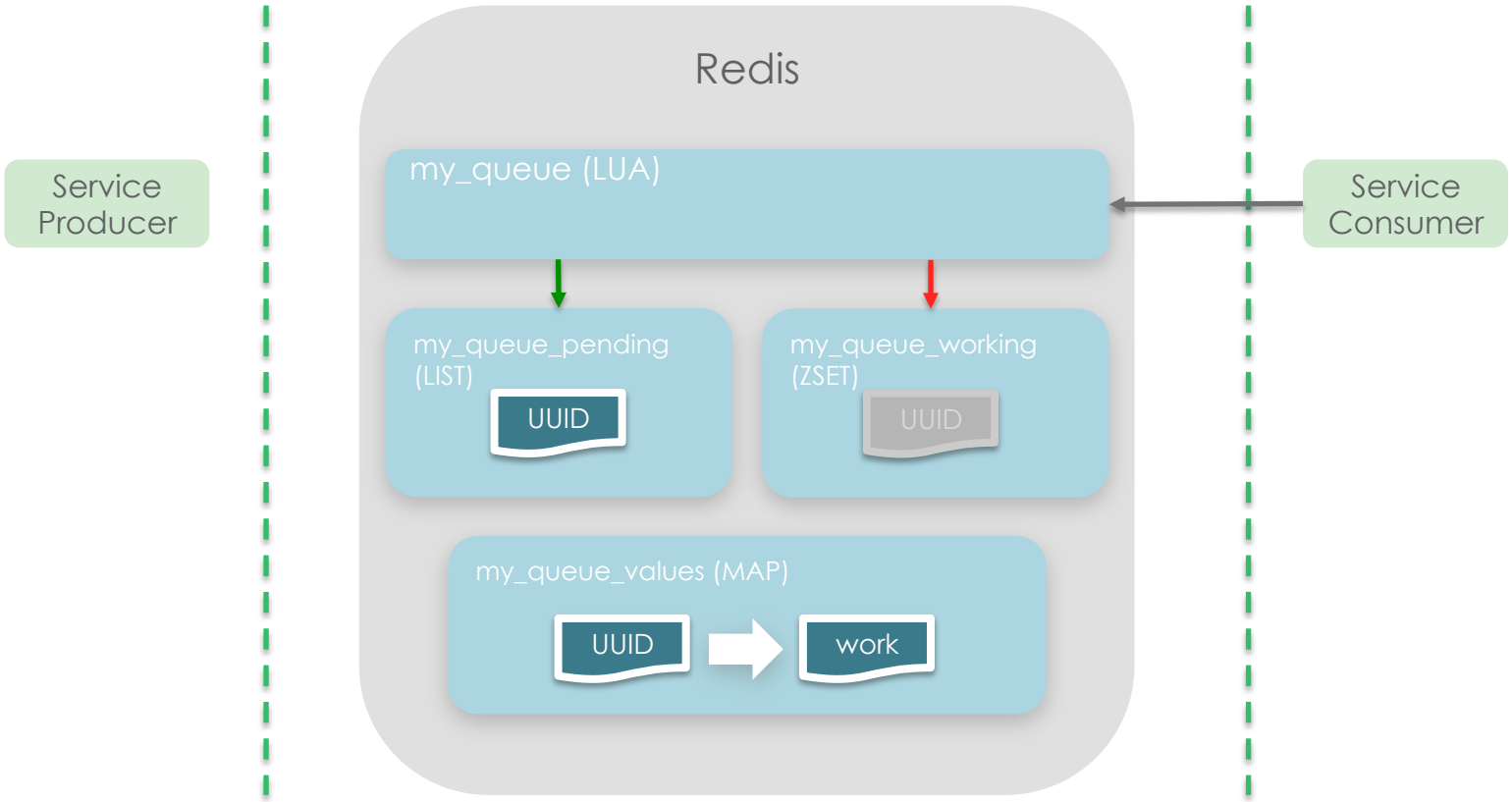
requeue()
1. ZREM {UUID}
2. LPUSH {UUID}



Reliable Queueing

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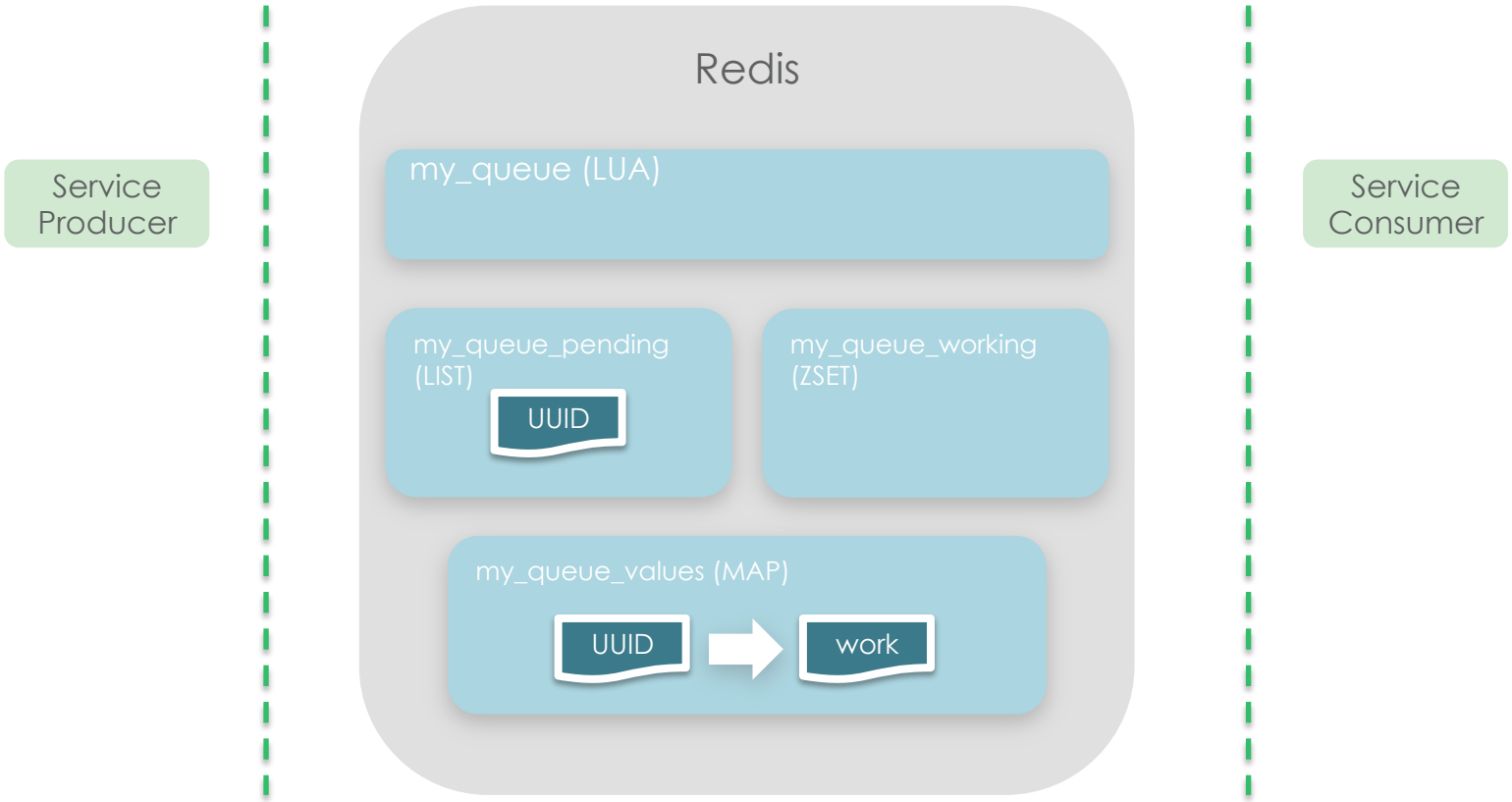
The work has now returned to the *pending* state, and will be reissued as soon as it returns to the head of the queue.



Reliable Queueing

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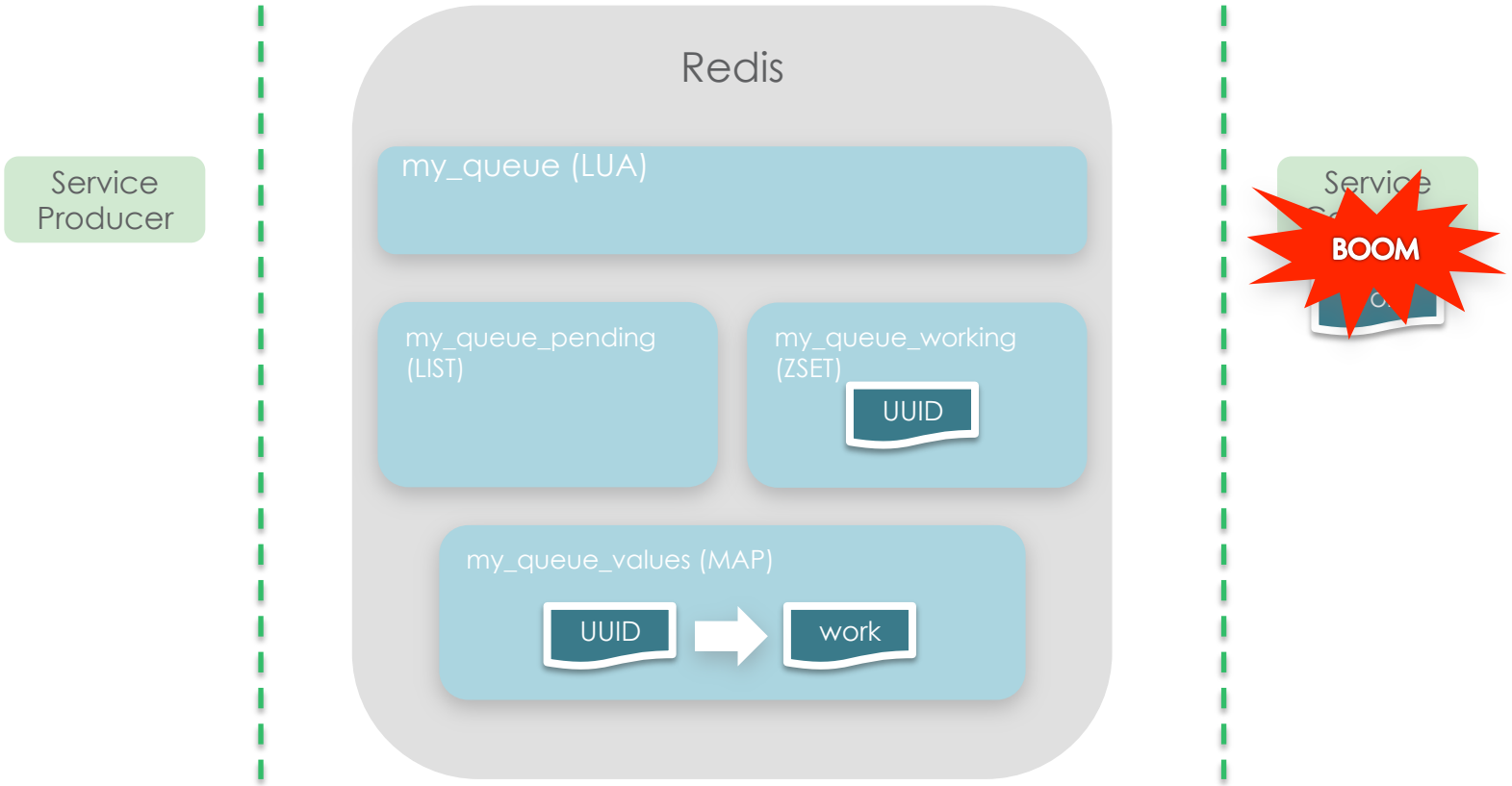
What if something *really* goes wrong during processing?



Reliable Queueing

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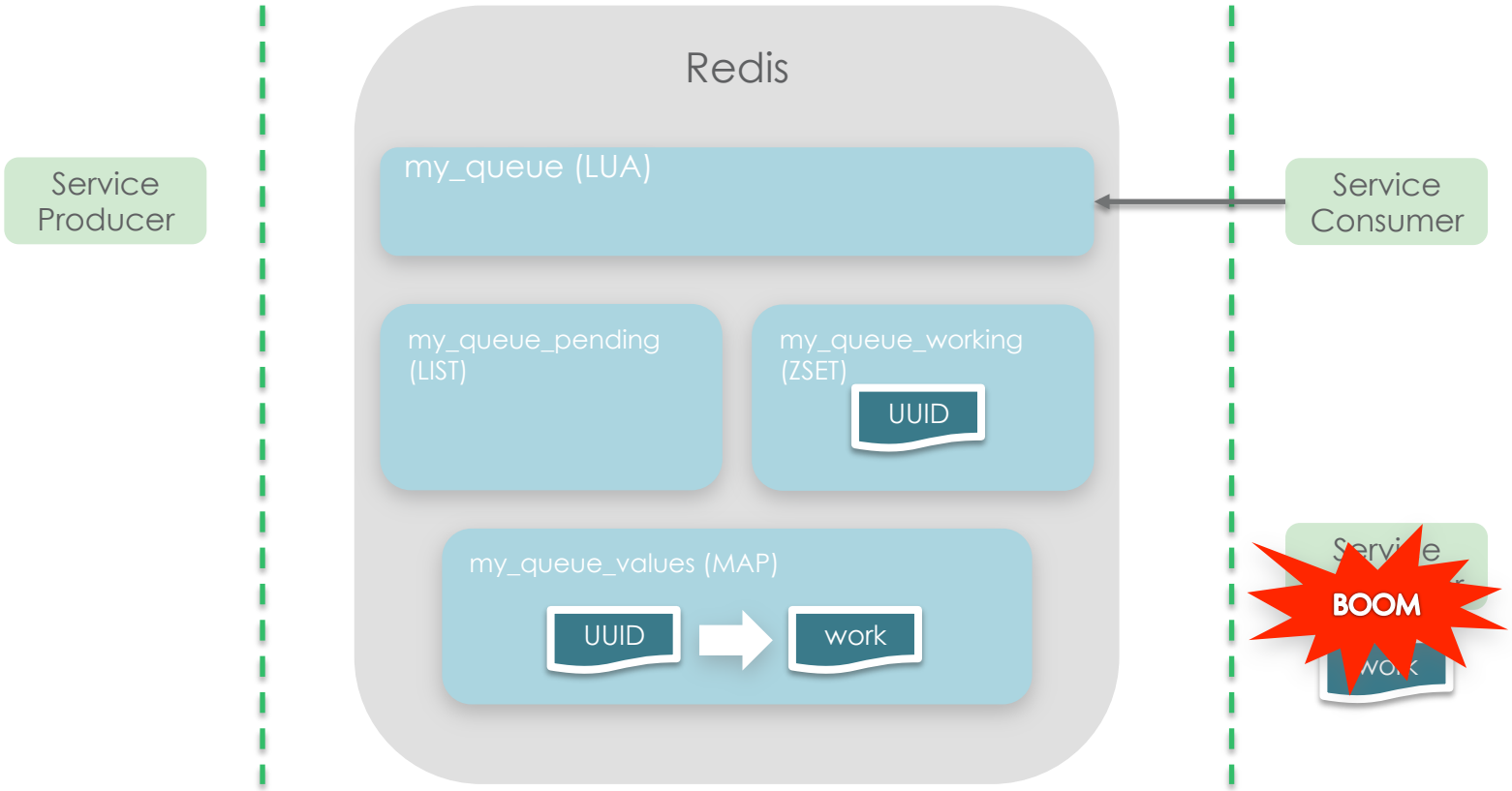
sweep()



Reliable Queueing

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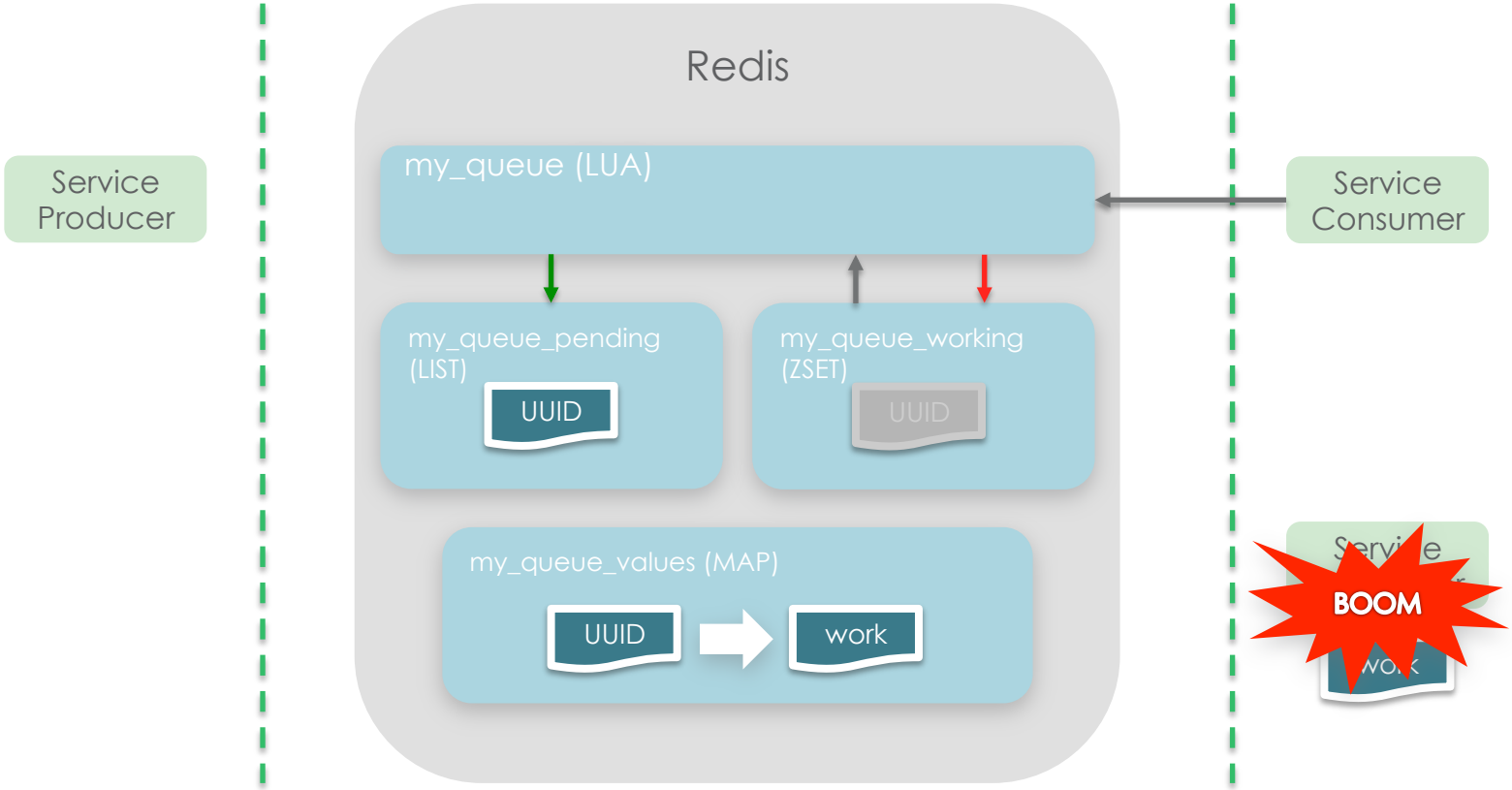
sweep()

1. ZRANGEBYSCORE my_queue_working 0 {timestamp – stale}
2. LPUSH my_queue_pending {UUIDs}
3. ZREM {UUIDs}



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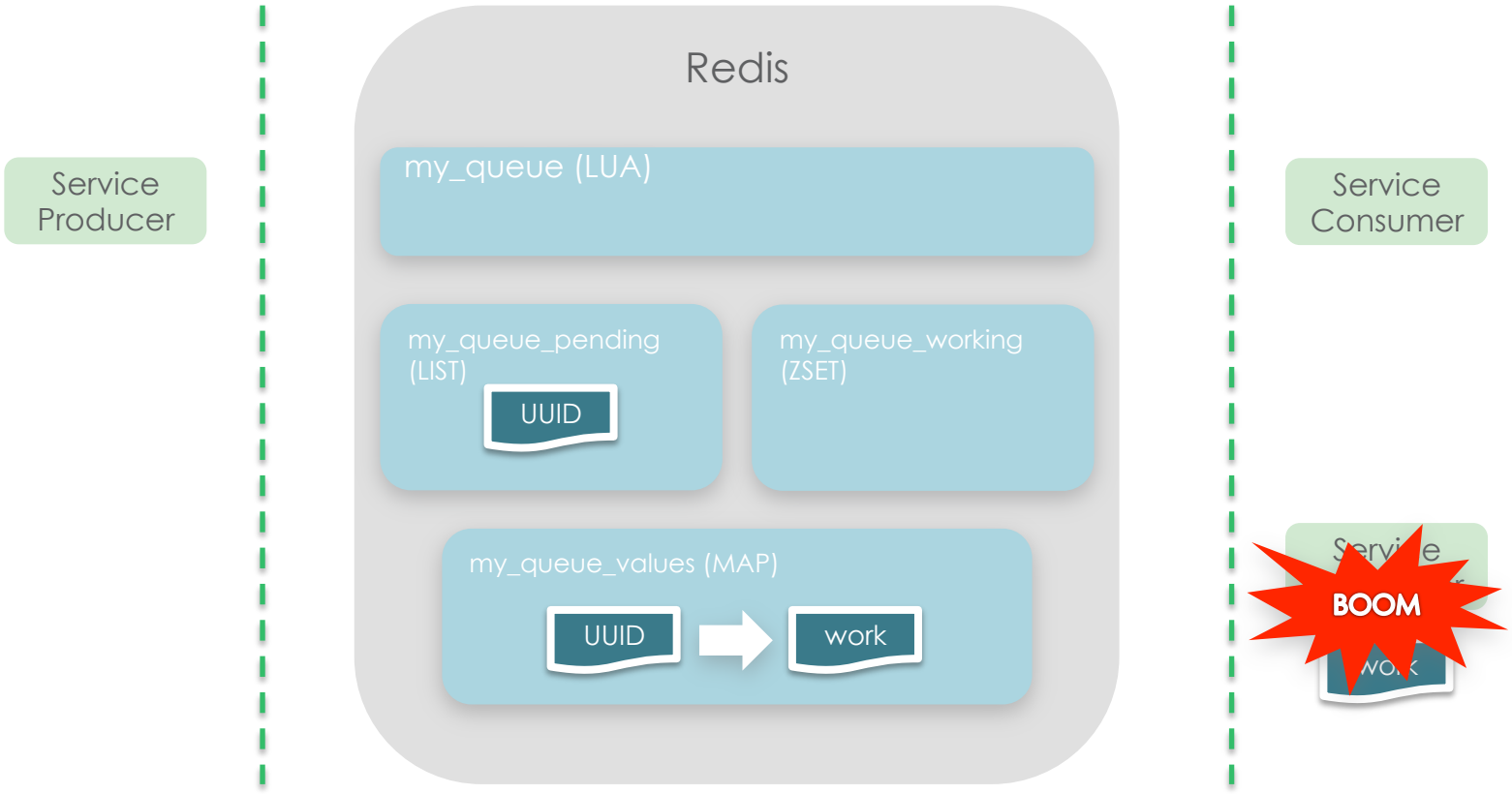

Reliable Queueing

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The real implementation does a lot more…

- Asynchronous API
- Operation pipelining
- Opportunistic batching
- Pre-fetching
- Per-item deferment
- Per-item statistics
  - Enqueue time
  - Dequeue time / count
  - Requeue time / count
- Metrics instrumentation
  - Queue throughput & timing
  - Batching effectiveness
  - Queue size
  - Queue lag

Reliable Queueing

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Some benchmarks…

- Bronto's Redis Client implementation
- Bronto's Reliable Queue implementation
- Redis running on Intel(R) Xeon(R) CPU E5-2430 @ 2.20GHz
- All tests are single threaded, with one connection
- All tests use single byte queue name and item payload

Scenario	Enqueue	Dequeue & Release
No pipelining, No batching	6,700 items/sec	2,900 items/sec
Pipelining (1024), No batching	62,040 items/sec	14,029 items/sec
Pipelining (1024), Batching (256)	236,922 items/sec	70,706 items/sec

Bronto Open Source

We are planning on releasing the entire suite to the open source community.

- Redis Client
  - Asynchronous
  - Pipelining
  - Protocol access
  - Scripting supports
- Redis Benchmarking Tools
  - Scriptable benchmark runs
  - Support for rapid LUA iteration and testing
- Bronto's Reliable Queue implementation
  - Everything you just heard about

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Coming this Spring.

Thanks for listening!

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Questions?